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18 MATERIALS, NONMETALLIC
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33 THERMODYNAMICS AND COMBUSTION

Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants. **1380**

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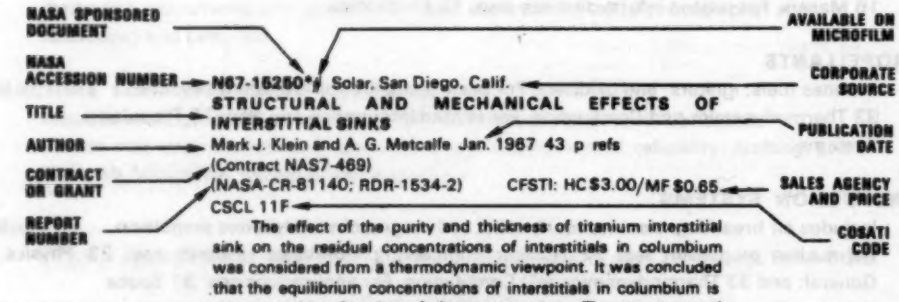

The effect of the purity and thickness of titanium interstitial sink on the residual concentrations of interstitials in columbium was considered from a thermodynamic viewpoint. It was concluded that the equilibrium concentrations of interstitials in columbium is not a sensitive function of these parameters. The structure and hardness of Ti/D-43 diffusion couples were correlated with the partitions of interstitials between the two metals. A reduction in the oxygen and carbon concentration in the D-43 correlates with an increase in the grain size and a change in the grain morphology of this alloy. The equilibrium partition of interstitials between the titanium and the D-43 is believed to account for an increase in the hardness of the titanium but this partition does not seem to affect the hardness of the D-43. Author

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Scientific and Technical Aerospace Reports

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01 AERODYNAMICS

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N67-18219 Lockheed Missiles and Space Co., Palo Alto, Calif.
HYPERSONIC FLOW AROUND AXISYMMETRIC BODIES FLYING AT AN ANGLE OF ATTACK
V. B. Minostsev [1961] 6 p refs Transl. into ENGLISH from Tr. Mosk. Fiz.-Tekhn. Inst. (Moscow), no. 7, 1961 p 136–151

Presented herein is the solution of the problem of angle-of-attack flow around axisymmetric bodies by an ideal gas moving at hypersonic velocities. The problem is solved by the method of expanding the desired flow characteristics. The solution is obtained in quadratures in a first approximation. Author

N67-18256# Aeronautical Research Council (Gt. Brit.)
BOUNDARY LAYER SEPARATION IN A CENTREBODY NOZZLE WITH PARALLEL SHROUD
M. V. Herbert and R. J. Herd London, HMSO, 1966 16 p refs Supersedes NGTE-R-271; ARC-27306
(ARC-CP-853; NGTE-R-271; ARC-27306; AD-800218) CFSTI: HC $3.00/MF $0.65

A nozzle has been tested with conical centrebody and a parallel outer shroud long enough to give a large measure of internal expansion. Centrebody pressure distributions have been obtained corresponding to both laminar and turbulent boundary layers. The critical Reynolds number criteria, previously deduced for convergent–divergent nozzles, are found to apply fairly well to the present shape. Author (TAB)

N67-18257# Aeronautical Research Council (Gt. Brit.)
AN OPTICAL METHOD OF MEASURING FLOW VELOCITY IN AN ARC-HEATED WIND TUNNEL
D. J. Buckingham (Southampton Univ.) London, HMSO, 1966 29 p refs Supersedes AASU-262; ARC-26741
(ARC-R&M-3439; AASU-262; ARC-26741) CFSTI: HC $3.00/MF $0.65

An optical method has been devised to measure velocity in the flow from an arc-heated wind tunnel. This method does not require the knowledge of any flow condition, and it does not interfere with the flow. Velocity measurements have been made in the flow from the arc-heated wind tunnel using this technique. These results have been compared with the results of a Langmuir probe survey made under the same conditions, and it has been found that they lie within the uncertainty of the Langmuir probe data. Refinements to the apparatus are suggested. Author

N67-18266# Aeronautical Research Council (Gt. Brit.)
LOW-SPEED WIND-TUNNEL EXPERIMENTS ON A SERIES OF SHARP-EDGED DELTA WINGS
P. B. Earnshaw and J. A. Lawford London, HMSO, 1966 39 p refs Supersedes RAE-TN-AERO-2780; RAE-TN-AERO-2954; ARC-23111; ARC-26032; see X64-15598
(ARC-R&M-3424; RAE-TN-AERO-2780; RAE-TN-AERO-2954; ARC-23111; ARC-26032) CFSTI: HC $3.00/MF $0.65

A series of six delta wings of varying angles of sweepback has been tested. A three-component strain-gauge balance was used to investigate the forces and moments, and normal-force fluctuations for incidences between $\pm 60°$. Positions of vortex breakdown on these wings are noted. Surface flow pattern and boundary-layer transition observations were made. The three most highly swept wings (i.e. having sweepback angles of 65°, 70° and 76°) appeared to have the most favorable characteristics of growth of normal-force fluctuations and had a smooth variation of forces and moments throughout the incidence range between positive and negative stalls. The change from a vortex type of flow to one with complete flow reversal on the upper surface occurred at increased incidence with increase of sweepback angle. At moderate incidence α the main features of the flow pattern correspond to conical flow development, and correlate well with the single parameter $\alpha/\cot\phi$, where ϕ is the sweepback angle of the leading edge. Author

N67-18267# Aeronautical Research Council (Gt. Brit.)
LOW-SPEED TUNNEL TESTS OF AN ASPECT-RATIO 9 JET-FLAP MODEL, WITH GROUND SIMULATION BY MOVING-BELT RIG
S. F. J. Butler, B. A. Moy, and G. D. Hutchins London, HMSO, 1966 33 p refs Supersedes RAE-TN-AERO-2957; ARC-26078; see X64-15734
(ARC-CP-849; RAE-TN-AERO-2957; ARC-26078) CFSTI: HC $3.00/MF $0.65

To assess the adequacy of the conventional stationary tunnel groundboard technique, particularly for V/STOL models exhibiting large, and often adverse, ground effects, tests were made on some representative models, including a jet-flap model. Using the moving-belt rig, the spurious relative motion between the mainstream and the simulated ground surface was eliminated, and more representative ground boundary-layer flows were achieved. With the jet-flap model, the gound boundary-layer condition only

had an important influence once jet sheet impingement occurred. Thus, the wing incidence at which an appreciable proportion of the jet efflux flowed upstream along the ground was some 10° higher with the ground surface in motion. The use of a moving ground surface was preferable under these conditions, since it resulted in appreciably higher values of wing lift and stalling incidence, as well as changes in drag, pitching moments, and downwash. These tests generally confirmed the original fixed groundboard tests used to predict the takeoff and landing behavior of the Hunting jet-flap research aircraft. Author

N67-18402*# Pratt and Whitney Aircraft, West Palm Beach, Fla. Research and Development Center.
SINGLE STAGE EXPERIMENTAL EVALUATION OF SLOTTED ROTOR AND STATOR BLADING. PART IV: DATA AND PERFORMANCE FOR SLOTTED ROTOR 2
24 Feb. 1967 97 p refs
(Contract NAS3-7603)
(NASA-CR-54547; PWA-FR-2111) CFSTI: HC $3.00/MF $0.65 CSCL 01C

A single-stage investigation of a slotted rotor was conducted as part of an overall program to evaluate the effect of slots on the performance of highly loaded compressor rotor and stator blade rows. The test rotor blades were 65-series airfoils having a calculated unslotted D-factor loading of 0.51 and an inlet relative Mach number of 0.833 at a radial station 10% of the span from the blade tip. For design equivalent rotor speed, the slotted rotor achieved a maximum adiabatic efficiency of 88.5% and a corresponding pressure ratio of 1.29. Author

N67-18406*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
INVESTIGATION OF TURBULENT SEPARATED FLOWS IN THE VICINITY OF FIN-TYPE PROTUBERANCES AT SUPERSONIC MACH NUMBERS
Earl A. Price, Jr. and Robert L. Stallings, Jr. Washington, NASA, Feb. 1967 81 p refs
(NASA-TN-D-3804) CFSTI: HC $3.00/MF $0.65 CSCL 01A

An experimental investigation has been conducted on the separated and associated disturbed flow region resulting from the presence of a fin-type protuberance in a turbulent boundary layer approximately 15.24 cm thick. Results were primarily obtained from pressure measurements over a Mach number range from 2.3 to 4.44 and Reynolds numbers per meter from 4.9×10^6 to 14.7×10^6. The thickness, sweep, and height of the fin-type protuberances were varied. Increasing the sweep of the protuberance was found to decrease sharply the upstream extent of disturbed flow. The extent of the upstream disturbed flow increased linearly with protuberance diameter. The first peak pressure coefficient was found to be significantly lower than values from two-dimensional separated flow. An irregular pressure distribution was found along that portion of the protuberance leading edge submerged within the boundary layer for certain models. Both the first peak and final peak pressure ratios increased with increasing Mach number for any given model. Varying the free-stream Reynolds number by a factor of three had no effect on the extent of upstream disturbed flow. Author

N67-18408*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EFFECT OF ORIFICE SIZE AND HEAT-TRANSFER RATE ON MEASURED STATIC PRESSURES IN A LOW-DENSITY ARC-HEATED WIND TUNNEL
R. W. Guy and R. M. Windberger Washington, NASA, Feb. 1967 39 p refs
(NASA-TN-D-3829) CFSTI: HC $3.00/MF $0.65 CSCL 01A

Heat-transfer and pressure measurements were obtained over a range of tunnel test conditions with Mach number varying from 12.2 to 14.1, total enthalpy varying from 3.07 to 4.95 MJ/kg (1320 to 2130 Btu/lbm), free-stream Reynolds number varying from 400 to 889 per centimeter (1.22×10^4 to 2.71×10^4 per foot) and free-stream mean-free-path length varying from 0.234 to 0.452 mm (0.0092 to 0.0178 inch). The pressure data taken with heat transfer to the model showed a significant decrease in measured pressure with a decrease in orifice diameter. The results show that the proper size orifice to use in a particular situation will depend on both the density level and the heat-transfer rate. The orifice effect should be considered in experimental pressure data obtained in low-density flow with heat transfer. Author

N67-18409*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
STATIC LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF A PROPOSED DECELERATOR TEST VEHICLE
Richard D. Samuels and Roger H. Fournier Washington, NASA, Feb. 1967 21 p ref
(NASA-TN-D-3862) CFSTI: HC $3.00/MF $0.65 CSCL 01A

Tests were conducted to determine the static longitudinal aerodynamic force and moment characteristics of a proposed decelerator test vehicle through a Mach number range from 0.6 to 2.86 and angles of attack from approximately −4° to 20°. The investigation yielded the following results: (1) At angles of attack below approximately 6°, there was no variation in normal-force or pitching-moment characteristics; however, at higher angles of attack, variations in these characteristics were noted. Two configurations were tested and both were unstable over the Mach number and angle-of-attack range. (2) The base axial force is the major portion of the axial force (approximately one-half) at the lower Mach numbers, and, although the base axial force decreases with increasing Mach number, approximately one-third of the axial force at Mach 2.86 is still due to the base axial force. Author

N67-18429 Aeronautical Research Council (Gt. Brit.)
FURTHER EXPERIMENTAL INVESTIGATIONS OF THE CHARACTERISTICS OF CAMBERED GOTHIC WINGS AT MACH NUMBERS FROM 0.4 TO 2.0
L. C. Squire London, HMSO, 1963 36 p refs Supersedes RAE-TN-AERO-2803; ARC-23724; see X62-10547
(ARC-R&M-3310; RAE-TN-AERO-2803; ARC-23724) CFSTI: HC $3.00/MF $0.65

The wind-tunnel tests on cambered gothic wings reported in Reports and Memoranda No. 3211 have been extended to include the effects of changes in design lift coefficient and of changes in spanwise camber without changes in camber incidence distribution. It was found that the camber was successful in that the flow was attached over the whole wing at the design lift. Also at the design lift the lift-dependent drag was close to the predicted values. However, the lift-dependent drag of the uncambered wing was also close to this value so that the benefit of camber on lift/drag ratio was very small. At subsonic speeds the cambered wings were less stable than the uncambered wing; also the changes of stability with incidence and Mach number were greater, particularly near M = 1.0. Changes in spanwise camber without changes in incidence distribution do not alter the force characteristics near the design lift, but do alter the off-design characteristics. Author

N67-18557# McGill Univ., Montreal (Quebec). Mechanical Engineering Research Labs.
HYPERSONIC PROPULSION LABORATORY Annual Report, 1966
Nov. 1966 49 p refs
(Grant DRB-G-9550-06)
(MEMO-66-4) CFSTI: HC $3.00/MF $0.65

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N67-18673 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.

ON TWO AERETHERMODYNAMIC PROBLEMS: THE MIXTURE OF TWO FLUIDS OF DIFFERENT ENTHALPIES AND THEIR THERMAL SEPARATION IN A VORTEX TUBE [SUR DEUX PROBLEMS D'AERETHERMODYNAMIQUE: LE MELANGE DE DEUX FLUIDES A ENTHALPIES DIFFERENTES ET LA SEPARATION THERMIQUE DANS UN TUBE TOURBILLON]

J. Fabri *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 21–22 (See N67-18661 08-34) CFSTI: $3.00

Aerothermodynamic problems of high speed atmospheric propulsion, and flight simulation of space vehicles are briefly highlighted. In this connection, classic regimes of supersonic ejector functioning are considered. The behavior of cylindrical mixers to fluxes of different enthalpies is emphasized, and the experiment mentioned verifies theoretical data. Two methods of thermal separation in a vortex tube are briefly described, and the hypotheses advanced may be used to evaluate the radius of separation of both fluxes. It is then possible to introduce in these aerothermodynamic equations the magnitudes necessary to analyze the thermal separation process. Transl. by R.Ll.

N67-18683 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.

EVOLUTION OF METHODS OF MEASURING SUPERSONIC WINGS [EVOLUTION DES METHODES DE CALCUL DES AILES SUPERSONIQUES]

M. Fenain *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 37–38 (See N67-18661 08-34) CFSTI: $3.00

A simple, fast, and high-precision method both in stationary and nonstationary regimes, was developed to calculate supersonic airfoil measurements. A basic formula was selected to define the classic aerodynamic wing and to calculate various specified effects. Transl. by R.Ll.

N67-18690*# Pratt and Whitney Aircraft, West Palm Beach, Fla. Florida Research and Development Center.

SINGLE STAGE EXPERIMENTAL EVALUATION OF SLOTTED ROTOR AND STATOR BLADING. PART III: DATA AND PERFORMANCE FOR SLOTTED ROTOR 1

21 Feb. 1967 110 p refs

(Contract NAS3-7603)

(NASA-CR-54546; PWA-FR-2110) CFSTI: HC $3.00/MF $0.65 CSCL 01A

A single stage investigation of a slotted rotor was conducted as part of an overall program to evaluate the effect of slots on the performance of highly loaded compressor rotor and stator blade rows. The test rotor blades for this investigation were 65-series airfoils having a calculated unslotted tip D-factor loading of 0.465 and tip relative inlet Mach number of 0.772 at a radial station 10% of the span from the balde tip. For design equivalent rotor speed, the slotted rotor achieved a maximum adiabatic efficiency of 93.4% and a corresponding pressure ratio of 1.33. Author

N67-18706 Aeronautical Research Council (Gt. Brit.)

TESTS AT TRANSONIC SPEEDS ON WINGS WITH WEDGE SECTIONS AND SWEEP VARYING BETWEEN 0° AND 60°

E. W. E. Rogers, C. J. Berry, and V. G. Quincey Apr. 1960 104 p refs Supersedes ARC-23180; see X65-84482

(ARC-R&M-3348; ARC-23180) CFSTI: $3.00

Tests have been made in the N.P.L. 18 in. by 14 in. High-Speed-Tunnel at stream Mach numbers between 0.6 and 1.2 on two finite wings of identical planform and having single-wedge and double-wedge sections of 14% and 7% thickness/chord ratio respectively. The wings were untapered and the sweepback could be set at five values: 0°, 15°, 30°, 45° and 60°. The test Reynolds number based on the streamwise chord varied with stream Mach number and wing sweepback, and was between 1.3×10^6 and 3.4×10^6. The experiment was intended to assist in assessing the validity of the simple sweepback concepts currently in use, particularly for predicting the flow about infinite sweptback wings from two-dimensional data. The three-dimensional effects present are reduced to some extent by the type of section used, especially at transonic speeds, and the measured pressure distributions at a particular spanwise station, and the associated pressure forces (normal and chordwise) correlate quite well on the basis of the simple theory. In addition it is shown that the general flow development, including the initial growth of the leading-edge separation, and the transonic flow-attachment about the leading edge also correlate satisfactorily, as do the pressures measured on the base of the single-wedge wing. There is some discussion on the effect of shock sweep on the conditions required for shock-induced boundary-layer separation and a modification is suggested to the curve put forward tentatively in Ref. 8. Author

N67-18766*# Itek Corp., Palo Alto, Calif. Vidya Div.

A THEORETICAL INVESTIGATION OF THE AERODYNAMICS OF SLENDER WING-BODY COMBINATIONS EXHIBITING LEADING-EDGE SEPARATION

Alvin H. Sacks, Raymond E. Lundberg, and Charles W. Hanson Washington, NASA, Mar. 1967 116 p refs
(Contract NAS2-2620)
(NASA-CR-719) CFSTI: HC $3.00/MF $0.65 CSCL 01A

Calculation of the normal force and center of pressure on plane wing–body combinations exhibiting leading edge separation is considered. The mathematical model for the separated flow involves the shedding of a number of discrete vortex pairs along the wing leading edge, each pair satisfying the Kutta condition at the position of shedding. Two techniques are presented for predicting the rate of shedding of vorticity along the wing leading edge: theoretical method that predicts the shedding rate analytically but is restricted to very slender configurations and a semi-empirical method that uses delta wing experimental data to predict the shedding rates on wings of general planform and on wing–body combinations. Numerical calculations were carried out for wings and wing–bodies with aspect ratios of 0.5 to 2.0. The semi-empirical method was well behaved in all cases, but convergence appeared to deteriorate for the theoretical method as the aspect ratio increased. The theoretical method over-predicts the nonlinear separated normal force, particularly for aspect ratios above 1.0. However, the semi-empirical technique yields satisfactory agreement with experiment for both normal force and center of pressure on the wings and wing–body combinations investigated. Author

N67-18949*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
APPLICATION OF RICHARDSON'S EXTRAPOLATION TO NUMERICAL EVALUATION OF SONIC-BOOM INTEGRALS
William B. Igoe Washington, NASA, Mar. 1967 30 p refs
(NASA-TN-D-3806) CFSTI: HC $3.00/MF $0.65 CSCL 01A

An application of Richardson's extrapolation to the numerical evaluation of the sonic-boom integrals occurring in the theory of Whitham has been considered. Equations have been developed for evaluating the sonic-boom integrals, by using second derivatives which are obtained from the central difference formulas of finite difference techniques. It has been shown by error analysis that these equations have an order of error proportional to the square of the solution point interval spacing for the far-field sonic-boom integral, and to the three-halves power of the interval spacing for the near-field sonic-boom integral. Extrapolation of the numerical results to zero interval spacing on the basis of the predicted order of error is demonstrated, and some numerical examples confirm the essential validity of this procedure. Some of the numerical results, however, show that the extrapolation technique must be used with caution. Author

N67-19262# Boeing Co., Renton, Wash. Commercial Airplane Div.
SOME EFFECTS OF BLADE CHARACTERISTICS ON COMPRESSOR NOISE LEVEL
B. Hulse, C. Pearson, M. Abbona, and A. Andersson Oct. 1966 92 p refs
(Contract FA-65-WA-1263)
(FAA-ADS-82)

Sound power level and airflow measurements were obtained for flat, cambered, and airfoil blades, with and without twist. A single-stage axial flow compressor or fan of low pressure ratio was used, the simplified design being dictated by the variety of blade shapes tested. Data are given for the dependence of sound power level on flow coefficient, air weight flow, relative tip velocity, and rotational speed. The sound power per unit weight flow appears to be independent of blade shape. The discrete-frequency noise from a freely running rotor is predicted to an order of magnitude in agreement with experimental results by an equation that is intuitively derived from an extension of propeller theory. Author

N67-19299# Southampton Univ. (England). Dept. of Aeronautics and Astronautics.
A STUDY OF THE OSCILLATING LAMINAR SEPARATED FLOW AHEAD OF A FORWARD FACING STEP OSCILLATING TRANSVERSELY TO A HYPERSONIC FREE STREAM
R. A. East and P. R. Wilkinson *In* AGARD Separated Flows, Pt. II May 1966 p 509–537 refs (See N67-19297 08-12)
CFSTI: HC $3.00/MF $0.65

A theoretical and experimental study is presented of the oscillating laminar separated flow formed ahead of a forward facing step which is oscillating transversely to a hypersonic free stream. The experimental results demonstrate that the separated flow region does not behave in a quasi-steady manner and that appreciable phase differences exist between the movement of the separation point and that of the step. The experiments were performed in a hypersonic gun tunnel at Mach numbers in the range $8.4 < M < 12.5$ and unit Reynolds numbers of 10^6 to 10^7 per foot. The theoretical work suggests certain parameters upon which the characteristics of this phenomenon depend. These are examined in the light of the experimental results. Author

N67-19300# Technische Hochschule Aachen (West Germany). Aerodynamisches Inst.
THE CONDITIONS OF SEPARATION AND VORTEX FORMATION PAST CYLINDERS
A. Naumann, M. Morsbach, and C. Kramer *In* AGARD Separated Flows, Pt. II May 1966 p 539–574 refs (See N67-19297 08-12) CFSTI: HC $3.00/MF $0.65

A summary is given of the results of experiments on flow pattern and flow-separation conditions past circular cylinders and through cylinder gratings. The interaction between local shock waves and the boundary-layer separation in flow régimes at critical Mach number is dealt with. At high (supercritical) Reynolds numbers, shock waves produce a well-defined separation line parallel to the cylinder axis and a vortex street occurs. Experiments are described on conditions of separation at supercritical Reynolds numbers in incompressible flow. Regular vortex formation involves a linear separation line parallel to the cylinder axis and it also depends on differences of circulation in the separating discontinuity surface. The flow behavior past gratings consisting of a single row of circular cylinders is treated. The characteristic results are the interaction between parallel vortex streets and the calculation of the stable arrangements. The speeds ranged from low values of Mach numbers to high subsonic Mach numbers at which choking occurred. Author

N67-19303# General Applied Science Labs., Inc., Westbury, N. Y.
SHOCKWAVE-LAMINAR BOUNDARY-LAYER INTERACTION. INTEGRAL ANALYSIS AND EXPERIMENTAL RESULTS
A. Martellucci and F. W. Lipfert *In* AGARD Separated Flows, Pt. II May 1966 p 635–665 refs (See N67-19297 08-12)
CFSTI: HC $3.00/MF $0.65

The shock wave–boundary-layer interaction problem is considered from two aspects: an integral method for analyzing laminar flows, and an experimental study of impinging shocks at Mach No. 5.4 under laminar and transitional conditions. The analysis considers the general case of a planar shock wave, which is swept with respect to the flow external to the boundary layer, and shows that it can be reduced to a two-dimensional problem. The technique of solution for the boundary-layer properties is based on the Kármán–Pohlhausen integral method for the momentum and energy equations, with the pressure distribution unknown and the velocity external to the boundary layer as the independent variable. The analysis is compared to experimental data for inpinging shocks from Mach No. 2.0 to 5.4; excellent agreement is shown for the purely laminar cases. Author

N67-19306# Cordoba National Univ. (Argentina). Aerodynamics Lab.

A STUDY OF AXIALLY SYMMETRICAL BASE FLOW BEHIND BODIES OF REVOLUTION AT SUPERSONIC SPEEDS

Joseph S. A. de Krasinki *In* AGARD Separated Flows, Pt. II May 1966 p 747–778 refs (See N67-19297 08-12) CFSTI: HC $3.00/MF $0.65

Detailed tests were made in the wake of axially cylindrical adiabatic models at M=1.48 and M=2.55. The tests included inverted flow measurements, and indicated that the separated flow field behind the base face forms a system where the mixing processes in the throat, the final energy level of the dividing streamline, and the intensity of the returned mass flow are connected together organically. This point of view reconciles the contradictory tenets of the dividing streamline and Crocco–Lees theories without accepting details. The dividing streamline as computed from measurements can reach, close to the base, an energy level above the maximum theoretical one, and its total pressure adjusts itself to the level prescribed by the mixing processes in the throat. Evidence was collected which confirms that the base pressure minimum can be reached when the mixing layer is laminar up to reattachment, and transition occurs abruptly in the throat. Profiles of the separated laminar boundary layer up to the beginning of recompression have a considerably lower momentum thickness than the fully developed laminar or turbulent ones. Author

N67-19307# London Univ. (England). Dept. of Aeronautical Engineering.

SOME RESULTS OF INVESTIGATIONS OF SEPARATION BUBBLES

A. D. Young and H. P. Horton *In* AGARD Separated Flows, Pt. II May 1966 p 779–811 refs (See N67-19297 08-12) CFSTI: HC $3.00/MF $0.65

Two-dimensional bubbles are discussed, as measured on aerofoils and later on a flat plate with a suitable pressure distribution induced by a nearby auxiliary wing, and also by a porous cylinder with circulation control provided by suction and a Thwaites flap. Gaster's criterion for the bursting of short bubbles is discussed and extended in the light of recent results. An argument is presented linking it with earlier criteria. Also discussed are data on three-dimensional bubbles on a swept plate similarly induced by a swept porous cylinder with a Thwaites flap. The results of streamwise and cross-flow velocity measurements, as well as pressure measurements, are presented and compared with the two-dimensional results. Author

N67-19308# National Physical Lab., Teddington (England).

THE STRUCTURE AND BEHAVIOUR OF LAMINAR SEPARATION BUBBLES

M. Gaster *In* AGARD Separated Flows, Pt. II May 1966 p 813–854 refs (See N67-19297 08-12) CFSTI: HC $3.00/MF $0.65

A study of laminar separation bubbles formed under a wide range of Reynolds numbers and pressure distributions has been made. The structure of the bubble depended on the value of the Reynolds number of the separating boundary layer and a parameter based on the pressure rise over the region occupied by the bubble. Conditions for the bursting of short bubbles were determined by a unique relationship between these two parameters. Hot wire measurements of both mean and fluctuating velocity in the separated region, together with oscilloscope records of the fluctuations, explain some of the flow mechanisms involved. Author

N67-19309# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Bochum (West Germany). Braunschweig und Ruhr-Universitaet.

THE SEPARATION OF THE TURBULENT BOUNDARY LAYER AS INFLUENCED BY BLOWING, SUCTION, MOVING WALL, AND PROPELLER SLIPSTREAM

K. Gersten *In* AGARD Separated Flows, Pt. II May 1966 p 855–886 refs (See N67-19297 08-12) CFSTI: HC $3.00/MF $0.65

The following experimental investigations have been carried out: (1) The effect of blowing tangentially into a boundary layer from a narrow slot on the location of separation, which occurs due to a strong adverse pressure gradient, has been investigated. (2) The effects of suction quantity on reattachment point, as well as on the boundary-layer characteristics downstream of the separation region, are shown. (3) The effect of spinning velocity on the boundary-layer along a body of revolution in axial flow was investigated in detail. The influence of the rotational velocity on the separation line is strongly connected with the increase of turbulence intensity within the boundary layer due to rotation. (4) The boundary-layer characteristics and the separation line on the rear part of a body of revolution have been measured. From these measurements it can be shown how the location of separation is affected by the thrust coefficient and the distance of the propeller. Author

N67-19350# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

SOME AERODYNAMIC PROBLEMS RELATED TO THE PROPULSION OF A HYPERSONIC AIRPLANE [QUELQUES PROBLEMES AERODYNAMIQUES LIES A LA PROPULSION D'UN AVION HYPERSONIQUE]

Jean-Pierre Bourgeois and Fabien Chiché 1966 56 p refs In FRENCH Presented at the 3d A.F.I.T.A.E. Colloq. on Appl. Aerodyn., Marseille-Istres, 8–10 Nov. 1966 Submitted for publication (TP-416) CFSTI: HC $3.00/MF $0.65

After a general presentation of some important parameters concerned with the air-intakes and exhaust nozzles of ramjet power plants on hypersonic airplanes, the following topics are discussed: a) initial compression under the lower surface of the delta-wing at a given angle-of-attack at hypersonic speed. b) efficiency of an external-internal supersonic compression, two-dimensional air-intake adapted to a subsonic combustion chamber. c) two-dimensional exhaust nozzles; the jet expansion calculations were carried out assuming that the gas is perfect ($\gamma = 1.4$) and that the gases are real (variable γ) in both cases: equilibrium and frozen flows. The study deals with the adaptation of the nozzle to a cruising Mach number and with the forces due to the propulsive jet (thrust, lift and pitching moment). Author (ESRO)

02 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics.

N67-18289# Aeronautical Research Council (Gt. Brit.)

A NOTE ON THE DECK LANDING VELOCITIES OF HELICOPTERS

M. A. P. Willmer London, HMSO, 1966 24 p Supersedes RAE-TN-NAVAL-56; ARC-25288; see X63-16903 (ARC-CP-854; RAE-TN-NAVAL-56; ARC-25288) CFSTI: HC $3.00/MF $0.65

A theory has been developed to act as a guide in the interpretation of experimental results of the landing velocities of helicopters on small ships at sea. It has been shown that the

concept of a normally distributed hover height together with a linear rate of decay of lift is satisfactory. A comparison has been made with results obtained from the rolling platform at Bedford and the agreement has been found to be quite good both for roll angles of 3 and 5 degrees. The theory has been extended to take into account the pitching motion of a ship with reasonable success. Author

N67-18285# Federal Aviation Agency, Washington, D. C. Economics Div.

DIRECT OPERATING COSTS AND OTHER PERFORMANCE CHARACTERISTICS OF TRANSPORT AIRCRAFT IN AIRLINE SERVICE FOR CALENDAR YEAR 1965

Sep. 1966 33 p

(AD-640678) CFSTI: HC $3.00/MF $0.65

The report describes measures of aircraft performance and direct operating costs achieved in recent airline service. It is designed specifically to show, for the various types of airline aircraft, data on utilization, seating capacities, speeds, fuel consumption, and average stage lengths as well as on direct operating costs and the elements thereof. TAB

N67-18380# Aeronautical Research Council (Gt. Brit.)

THE MOTION OF HELICOPTER BLADES AT LOW ROTOR SPEEDS IN HIGH WINDS

M. A. P. Willmer London, HMSO, 1966 50 p refs Supersedes ARC-25835

(ARC-CP-852; ARC-25835) HMSO: 10s

A theory for predicting the behavior of a rotor at low r.p.m. in a strong steady wind was developed. Results were obtained both for helicopters on the ground and on a rolling platform. It was found that, under steady conditions and with the helicopter on the ground, serious blade deflections are not likely to occur. However, with a helicopter on a raised landing deck, it is possible for the cliff-edge effect to be of major importance especially for helicopters with large rotors relative to the deck width. Finally the blade response to a vertical gust was investigated and it was shown that helicopter rotors are very susceptible to them. Author

N67-18400*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

STATIC AERODYNAMIC CHARACTERISTICS OF A MODEL OF A TYPICAL SUBSONIC JET-TRANSPORT AIRPLANE AT MACH NUMBERS FROM 0.40 TO 1.20

Eugene N. Brooks, Jr., John P. Decker, and James A. Blackwell, Jr. Washington, NASA, Feb. 1967 41 p refs

(NASA-TM-X-1345) CFSTI: HC $3.00/MF $0.65 CSCL 01C

An investigation was conducted in an 8-foot transonic pressure tunnel to determine the static aerodynamic characteristics of a model of a typical subsonic swept-wing, jet-transport airplane at angles of attack ranging from $-8°$ to $18°$ and Mach numbers of 0.40 to 1.20. The results indicate that the model was longitudinally stable at zero sideslip angle for lift coefficients between 0.15 to 0.50 corresponding to angles of attack up to about $3°$ in the Mach number range studied. In the same lift-coefficient range and at Mach numbers above 0.90, the model exhibited large increases in static margin with small changes in Mach number. At lift coefficients between 0.50 and 0.80, the static margin decreased to approximately zero for Mach numbers between 0.40 and 0.80. At lift coefficients greater than 0.80, corresponding to angles of attack greater than $7°$, the model was longitudinally stable at all Mach numbers except between 0.95 and 1.03. For small sideslip angles and at Mach numbers below 0.90, the model had positive effective dihedral; however, the model had negative effective dihedral for Mach numbers of 0.90 and 0.95 over significant portions of the lift-coefficient range. At a Mach number of 0.90, the model was longitudinally unstable for a sideslip angle of $5°$ in about the same lift-coefficient range in which the effective dihedral was negative. Weathercock stability was maintained for all Mach numbers and angles of attack. Author

N67-18686 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.

AERODYNAMIC OPTIMIZATION OF THE SUBSONIC AIRPLANE [OPTIMISATION AERODYNAMIQUE DE L'AVION SUBSONIQUE]

Ph. Poisson-Quinton *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 43 (See N67-18661 08-34) CFSTI: $3.00

Wind tunnel testing of certain aerodynamic problems of subsonic, jet transport planes are being studied to optimize the Air–Bus design. The cruising speed, the effects of incidence on the leading edge of the wing, and the pressure distribution, measured in a transonic wind tunnel, have a bearing on the wing profile considered. Transl. by R.Li.

N67-18784*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

STATUS OF SUPERPRESSURE BALLOON TECHNOLOGY IN THE UNITED STATES

E. D. Angulo, J. G. Guidotti, and C. E. Vest Dec. 1966 31 p refs

(NASA-TM-X-55701; X-724-66-593) CFSTI: HC $3.00/MF $0.65 CSCL 01C

Superpressure balloon technology in the United States is reviewed, and it is pointed out that long-life superpressure balloons have not been flown with satisfactory reliability. Problems of design, fabrication, and testing must be solved if large numbers of superpressure balloons are to be flown reliably and at reasonable cost. The results of literature searches are presented, together with observations arising from direct contact with the few U.S. firms producing superpressure balloons. It is recommended that a funded development and testing program be initiated to bring balloon technology to a satisfactory level, not only for the benefit of the FR-2 program, but for the future atmospheric research programs as well. Author

N67-18963*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EFFECT OF SKEWED WING-TIP CONTROLS ON A VARIABLE-SWEEP WING-FUSELAGE CONFIGURATION

Emma Jean Landrum and Josephine W. Grow Washington, NASA, Mar. 1967 97 p refs

(NASA-TN-D-3847) CFSTI: HC $3.00/MF $0.65 CSCL 01A

Basic aerodynamic data are presented for Mach numbers from 0.50 to 1.20. Correlations obtained from these data are combined with correlations from previous tests to provide a summary of the complete investigation in the Mach number range from 0.50 to 4.62. Wing-sweep angle varied from $30°$ to $75°$ through an angle of attack range from $-4°$ to $8°$, a sideslip angle range from $-4°$ to $6°$, and a control deflection angle range from $0°$ to $10°$. Hinge-line angle relative to the wing leading edge varied from $75°$ to $115°$. Reynolds number per foot varied from 1.44×10^6 to 3×10^6. The increments in lift, rolling moment, and pitching moment coefficients due to control deflection correlate linearly on the basis of simple geometric parameters such as projected frontal control area and projected frontal control area moment about a given axis. Deflection of the controls had little effect on the longitudinal and lateral stability characteristics. Yawing moment changed from favorable to adverse as the hinge-line angle relative to the wing leading edge varied from $115°$ to $75°$. Comparison of several controls with constant planform area showed that a control with the largest projected frontal area and moments was the most effective. However, this control also produced more drag and more adverse yawing moment. Author

N67-19068 Gt. Brit. Ministry of Aviation, London. Technical Information and Library Services.

METHOD FOR CALCULATING NOISE FROM JET AIRCRAFT ON TAKE-OFF TRAJECTORY [METHODE DE CALCUL DU BRUIT PRODUIT PAR DES AVIONS A REACTION, SUR LEUR TRAJECTOIRE DE DECOLLAGE]

M. Kobrynski Nov. 1966 21 p refs Transl. into ENGLISH from Rech. Aerospatiale (Chatillon-sous-Bagneux), v. 105, Mar.–Apr. 1965 p 55–63

(TIL/T-5673) CFSTI: $3.00

The laws of sound emission by stationary or in-flight jets and the directional characteristics of the noise are used to develop a method for calculating the noise that a jet aircraft will emit on takeoff trajectory. Relationships between the noise level to be found and various jet characteristics are specified; and the effect of jet drive velocity on the frequencies emitted is indicated. Maximum total and overall sound pressure levels are considered, as are the convection factor, aerodynamic effect, and various sound levels. Results obtained are applicable to turbojets without jet silencers, and are valid for convection Mach numbers up to 1.2 and flight Mach numbers up to 0.7. M.W.R.

N67-19242# Advisory Group for Aerospace Research and Development, Paris (France).

OVERCOMING GROUND EROSION EFFECTS IN THE OPERATION OF JET LIFT AIRCRAFT

J. M. Dent (Rolls-Royce, Ltd.) Oct. 1965 21 p Presented at 27th Meeting of AGARD Flight Mech. Panel, Rome, 11–12 Oct. 1965

(AGARD-516) CFSTI: HC $3.00/MF $0.65

A review is presented of rig tests to investigate the effects of ground erosion, especially in relation to damage caused by scattered debris. Different surfaces, such as grass pasture land, portable trackway, concrete, and asphalt were tested; and various operating techniques for solution of the problems of ground erosion are discussed. Author

N67-19243# Advisory Group for Aerospace Research and Development, Paris (France).

TESTING THE KESTREL

I. A. Fisher (Aeroplane and Armament Exptl. Estab.) Oct. 1965 22 p ref Presented at 27th Meeting of the AGARD Flight Mech. Panel, Rome, 11–12 Oct. 1965

(AGARD-518) CFSTI: HC $3.00/MF $0.65

This report describes flight tests on the Hawker Siddeley Kestrel, the first VTOL jet airplane in service anywhere in the world; it has speed range from backward flight to greater than Mach 1, without autostabilization. The trials were mainly qualitative, since the object was to assess the acceptability of the aircraft for squadron service. Discussion is concentrated on the more interesting aspects of V/STOL operation, such as stability in hovering and in accelerating transition to conventional flight, VTOL and STOL take off and landing techniques, rough ground operation, and V/STOL night flying. The pilots' impression is that the Kestrel is a surprisingly simple machine to fly, in all three flight regimes. Author

N67-19280*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

PERFORMANCE OF A 26-METER-DIAMETER RINGSAIL PARACHUTE IN A SIMULATED MARTIAN ENVIRONMENT

Charles H. Whitlock, Richard J. Bendura, and Lucille C. Coltrane Washington, NASA, Mar. 1967 38 p refs Film Supplement Number L-946 to this report is available on loan from NASA Langley Res. Center

(NASA-TM-X-1356) CFSTI: HC $3.00/MF $0.65 CSCL 01C

Inflation, drag, and stability characteristics of an 85.3-foot (26-meter) nominal diameter ringsail parachute deployed at a Mach number of 1.15 and at an altitude of 132,600 feet (40.42 kilometers) were obtained from the first flight test of the Planetary Entry Parachute Program. After deployment, the parachute inflated to the reefed condition. However, the canopy was unstable and produced low drag in the reefed condition. Upon disreefing and opening to full inflation, a slight instability in the canopy mouth was observed initially. After a short time, the fluctuations diminished and a stable configuration was attained. Results indicate a loss in drag during the fluctuation period prior to stable inflation. During descent, stability characteristics of the system were such that the average pitch-yaw angle from the local vertical was less than 10°. Rolling motion between the payload and parachute canopy quickly damped to small amplitude. Author

N67-19352# Advisory Group for Aerospace Research and Development, Paris (France).

SELECTED INSTRUMENTATION APPLICATION PAPERS FROM AGARD FLIGHT MECHANICS PANEL—TWENTY-SIXTH MEETING

Jun. 1965 54 p Meeting held in Paris, Jun. 1965

(AGARD-507) CFSTI: HC $3.00/MF $0.65

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N67-19353# Messerschmitt A. G., Augsburg (West Germany).

FLIGHT TEST INSTRUMENTATION, DATA REDUCTION AND DATA PROCESSING IN THE VJ 101 C X_1/X_2

H. Pornitz-Rumpff *In* AGARD Selected Instrumentation Appl. Papers from AGARD Flight Mech. Panel Jun. 1965 p 5–22 (See N67-19352 08-02) CFSTI: HC $3.00/MF $0.65

Telemetry, instrumentation testing, and transducer design of the VJ-101-C-X_1/X_2 experimental aircraft are described. The telemetry equipment for both airborne and ground use is briefly detailed. A typical program, and reports on experience with the test instrumentation system used are presented. Block diagrams illustrate the extensions planned to handle automatically the enormous amount of data, using a large digital computer. Also included are data reduction and data processing technical data on the X_1 and X_2 projects. R.Li.

N67-19354# North American Aviation, Inc., Los Angeles, Calif.

AN AIRBORNE DATA-ACQUISITION SYSTEM FOR USE IN FLIGHT TESTING THE XB-70 AIRPLANE

E. L. Edwards *In* AGARD Selected Instrumentation Appl. Papers from AGARD Flight Mech. Panel Jun. 1965 p 23–50 (See N67-19352 08-02) CFSTI: HC $3.00/MF $0.65

The performance requirements and data acquisition capabilities of a flight test data acquisition system for XB-70 aircraft are discussed. Though both analog and digital recording techniques are employed, details of the digital equipment are stressed. The sequence of operations performed from sensor signal conditioning through filtering, time multiplexing, amplification, analog-to-digital conversion, and tape recording is described. Equipment packaging and environmental control provisions, system performance under actual flight testing conditions, and data processing operations are also discussed. R.Li.

03 AUXILIARY SYSTEMS

Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems.

N67-18312*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
STERILIZABLE BATTERY
R. Lutwack *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 35–36 (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

Research programs focusing on the development of a separator for the Ag–Zn battery, and the evaluation of a modified polyethylene separator material; is reported. In evaluation of ligand polymers, it has been shown that 2-vinylpyridine-methacrylic acid and styrenemaleic acid copolymers and poly-(vinylbenzylcatechol) are stable under sterilization conditions. Composite membranes were prepared and tested in a 40% KOH solution at 135 for 60 hr. A combination of polypropylene and $Zr(OH)_4$ gave a membrane which could be sterilized and had adequate OH^- diffusion characteristics. The initiation of a study for investigating the process of grafting of polyethylene film with acrylic acid using a Co^{60} irradiation source is reported. Separator materials are being used in the design and performance evaluation of the sterilizable cells. Sterilized cells made with five layers of −116 were found to perform as well as controls after 40 cycles of 100% depth discharge. Research and development efforts on sealed Ag–Zn and Ag–Cd cells which provide satisfactory electrical performance after heat sterilization and high impact shocks is continuing. Reported are results of electrochemical studies, efforts to develop cell case materials, and cell fabrication and test data. S.C.W.

N67-18315*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PARAMETRIC ANALYSIS FOR STEADY-STATE PERFORMANCE OF ATTITUDE-CONTROL THRUSTERS
J. D. Ferrera and P. M. McKown *In its* Space Program Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 47–48 ref (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

A computerized parametric analysis of the steady state performance of an analytical model of a reaction jet was made in an effort to predict thrust and impulse bit. It was assumed that the flow through the system was isentropic and that any deviation of the annular valve orifice flow from that of a sharp-edged circular orifice of equal area was nullified by an experimentally determined orifice discharge coefficient. In the steady state operation, the flowrate through the valve orifice was equal to the flowrate through the nozzle throat. By application of this flowrate equality, an algebraic equation in terms of the valve chamber resulted which was readily solved using computer iteration. The maximum theoretical thrust was directly proportional to this chamber pressure. Thrust losses were subtracted from this maximum value to determine the net thrust. A computer curve-fitting program was used in determining the ratio of displacement thickness to momentum thickness in the boundary layer as a function of nozzle exit flow Mach number. As a preliminary demonstration of this analysis, a computer program was generated resulting in a computer plot of net steady state thrust from the valve–nozzle system as a function of nozzle throat diameter for a range of valve inlet pressures. Analytical values of valve pressure drop and flowrate correlated well with laboratory measurements, and theoretical values of net steady state thrust were within 5% of thrust levels from Mariner IV flight data. S.C.W.

N67-18397*# General Electric Co., Cincinnati, Ohio. Flight Propulsion Div.
ANALYTICAL PROCEDURE AND COMPUTER PROGRAM FOR DETERMINING THE OFF-DESIGN PERFORMANCE OF AXIAL FLOW TURBINES
E. E. Flagg Washington, NASA, Feb. 1967 234 p refs
(Contract NAS3-7262)
(NASA-CR-710; R66FPD258) CFSTI: HC $3.00/MF $0.65 CSCL 21E

The Fortran IV computer program and the numerical techniques used in the analysis are presented, along with a detail logic flow diagram and a symbol list equivalencing the analysis equation variables to the Fortran variables. The procedure is applicable to multistage axial flow turbines having any number of stages up through eight. It allows for a change in mean section radius between blade rows, and includes provisions for radial variation in loss and flow conditions. This variation is calculated at up to six radial positions at the radial center of fixed area sectors. The analysis is applicable from zero speed to high speed, and the work done may be negative to the maximum work condition limited by discharge annulus area choking. The computer program was demonstrated by calculating the performance map of a turbine of known performance. The map is presented along with sample input and output. M.G.J.

N67-18556* Moog Servocontrols, Inc., East Aurora, N. Y.
EVALUATION PROGRAM OF MAJORITY VOTING MECHANICAL FEEDBACK SERVOACTUATOR FOR THE SATURN S-IV B, VOLUME C
N. Van Iderstine 22 Jul. 1966 191 p refs
(Contract NAS8-11998)
(NASA-CR-82512, MR-1080) CFSTI: HC $3.00 CSCL 13G

A reliability study is reported which compares the relative failure probability of the Model 17-204 three-motor, majority voting servoactuator to that of the nonredundant Model 17-189 servoactuator presently utilized in the S-IV B propulsion–guidance system. Descriptions of both actuator systems are presented. Reliability estimates were calculated to be higher for the Model 17-204 for preflight countdown and flight conditions, but lower for ground checkout, due to greater possibility of early field failures. It was concluded that Model 17-204 is a feasible means of achieving in-flight reliability. N.E.N.

N67-18607# California Univ., Livermore. Lawrence Radiation Lab.
CURRENT-REGULATED D-C SUPPLIES WITH HIGH EFFICIENCY AND LOW COST
J. W. Robinson 23 Sep. 1966 14 p refs Presented at the Symp. on Eng. Probl. of Controlled Thermonucl. Res., Gatlinburg, Tenn., 3–6 Oct. 1966 Submitted for publication
(Contract W-7405-ENG-48)
(CONF-661016-12; UCRL-70020) CFSTI: HC $3.00/MF $0.65

A class of current-regulated d-c power supplies is described which should become available commercially in the near future. These supplies for use on magnetic field coils offer very good regulation and stability, ripple frequency independent of the line frequency with 1–2 kc easily obtained, ripple magnitude independent of operating point, and cost substantially lower than conventional supplies. The main difference between the power supplies to be discussed and familiar SCR or transistor-regulated supplies is that the controlling devices are operated in a saturated switching mode. This allows the use of relatively inexpensive components and also results in a supply with a high power conversion efficiency over its entire operating range. Author (NSA)

N67-18632*# Clevite Corp., Cleveland, Ohio. Electronic Research Div.
STUDY OF THIN FILM LARGE AREA PHOTOVOLTAIC SOLAR ENERGY CONVERTER Final Report

F. A. Shirland, J. R. Hietanen; and W. K. Bower 30 Dec. 1966 53 p refs
(Contract NAS3-8502; Proj. 303290)
(NASA-CR-72159) CFSTI: HC$3.00/MF$0.65 CSCL 10A

Design changes, introduced to remove causes of cell instability, decrease cell thickness and weight, increase reliability and decrease fabrication costs were successful, though only a few cells of the improved design have been tested so far on temperature cycling. Instability of cell output on shelf storage was eliminated by cementing the grids to cell barriers with conductive epoxy resin. A transient degradation of output during elevated temperature exposure was eliminated by using a gold pigmented epoxy. Degradation of cell output on exposure to humid ambients was eliminated by using a clear epoxy resin to attach the cover plastic to the cell. Cell and array reliability was improved by using a full width integral extension of the conductive substrate as the negative lead of the cell, and a full width integral extension of the collector grid as the positive lead. Cell thickness and weight were reduced while enhancing cell flexibility by reducing the CdS film thickness, the thickness of the substrate and cover plastic, and eliminating the cement joint for lead attachment by going to integral leads. Major economies in cell fabrication were effected by using a copper collector grid made by a photo-chemical etching process by substituting copper foil for molybdenum for the metal substrate cell, and by revising cell processing to mass production techniques.
Author

N67-18638*# Martin Co., Baltimore, Md.
STUDY OF A FLUIDIC ATTITUDE CONTROL SYSTEM FOR A SOLAR PROBE SPACECRAFT, PHASE I Technical Engineering Report
James L. Hinson Nov. 1966 134 p refs
(Contract NAS12-127)
(NASA-CR-80008; ER-14436) CFSTI: HC $3.00/MF $0.65 CSCL 13G

The Phase I activity of the program consists of a system requirement study for a fluidic Solar Probe Spacecraft Attitude Control System, and a comprehensive analysis and evaluation of all available fluidic elements, sensors, components, etc., that might be used to implement this attitude control system. This effort has shown that a fluidic approach for a spacecraft attitude control system is both feasible and promising in terms of eventual reliability and operational lifetime, but that the state of development of certain system components, notably closed-cycle fluidic power supplies, and some sensors, is lagging badly; and that much additional work needs to be done in establishing fluidic device performance at elevated ambient temperatures, and establishing criteria for reliability predictions of fluidic system performance.
Author

N67-18694*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A THREE-DIMENSIONAL ANALYSIS OF A TANGENTIAL YO-YO DESPIN DEVICE ON A ROTATING BODY
Robert L. Collins, Jr. Washington, NASA, Mar. 1967 43 p refs
(NASA-TN-D-3848) CFSTI: HC$3.00/MF$0.65 CSCL 22A

The problem of despinning a rotating rigid body by the release of yo-yo despin weights is considered. Although studies have been made previously for the two-dimensional case of a fixed spin axis, there has been little effort to incorporate an initial coning angle which, in general, leads to a three-dimensional problem. This study considers the effect of an initial coning motion on the parameters which influence the design of a yo-yo despin system. The differential equations of motion of the system are derived for a symmetric rigid body and these are integrated numerically to provide solutions for several specific cases. The results show that a two-dimensional study is sufficient to predict such parameters as cable length, cable tension, and time required to despin, as long as the initial coning angle is less than 10° to 30°, and the masses of the despin weights are not too small. The parameters plotted in this study give an indication of the effects of initial coning angle on the design parameters of interest for what is called tangential motion.
Author

N67-18700*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
LIGHTWEIGHT BATTERY CONTAINERS FOR EXPLORER XVII (1963 9A), THE ATMOSPHERIC STRUCTURE SATELLITE
Truman H. Aehle Oct. 1966 13 p
(NASA-TM-X-55688; X-723-66-517) CFSTI: HC $3.00/MF $0.65 CSCL 10C

The design of lightweight battery containers for the Explorer XVII satellite, based on using the batteries as structural members, is discussed. The container basically consists of a base plate, vertical angle members, cross tie members, and a cover plate that is bolted on. The fabrication of the aluminum alloy containers is described, and the tests conducted are reported. Results indicated that the battery containers operated in a satisfactory manner throughout all experimental, prototype, and flight tests, and the design permitted a battery-to-container weight ratio of 10 to 1.
L.E.W.

N67-18745*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
CIRCUIT CONSIDERATIONS FOR DC TO DC CONVERSION ABOVE 10 KHZ
G. Ernest Rodriguez Aug. 1966 28 p refs
(NASA-TM-X-55667; X-716-66-375) CFSTI: HC $3.00/MF $0.65 CSCL 10B

Various circuits have been developed for DC to DC conversion in the frequency range of 400 HZ to 10 KHZ. Conversion above 10 KHZ has usually been accomplished at the expense of efficiency. Power losses of several circuits are discussed and a method for optimizing the feedback loop of the "two transformer oscillator" for operation above 10 KHZ is formulated. The method is used in the design of a converter at 25 KHZ, and preliminary results are presented. Selection of the transformer core material is based on displayed hysteresis loops during circuit operation of two core materials.
Author

N67-18918*# Pratt and Whitney Aircraft, East Hartford, Conn.
TURBINE RESEARCH PACKAGE FOR RESEARCH AND DEVELOPMENT OF HIGH PERFORMANCE TURBOALTERNATOR Final Report
R. Cohen, W. K. Gilroy, and F. D. Havens Jan. 1967 77 p
(Contract NAS3-6013)
(NASA-CR-54885; PWA-2796) CFSTI: HC $3.00/MF $0.65 CSCL 10A

A two stage, axial flow turbine unit, designed to provide a high efficiency potential, is described. Defined as a test rig, this turbine research package is intended to provide cold flow aerodynamic performance data for the Brayton-cycle alternator drive turbine. It includes a 15 KVA, 4-pole inductor alternator supported on gas bearings; oil lubricated, rolling contact bearings are provided to permit evaluation of the turbine using low temperature gas. The package is able to operate with inlet temperatures up to 710°R, inlet pressures up to 23 psia, and rotational speeds up to 9350 rpm. The unit was tested mechanically to 20% over its design speed. It is reported that satisfactory mechanical characteristics were demonstrated, and the required acceptance test was completed.
M.G.J.

N67-19073* Naval Ammunition Depot, Crane, Ind.
SPACE CELL TEST PROGRAM Monthly Progress Report, Period Ending 30 Nov. 1966

10 Feb. 1967 163 p
(NASA Order 5-23404-G)
(NASA-CR-82500) CFSTI: $3.00 CSCL 10B

Life cycle test results are detailed for various nickel-cadmium, silver-zinc, and silver-cadmium fuel cells purchased by the Goddard Space Flight Center. Failure analysis, test parameters, and capacities are tabulated; and end of discharge and end of charge voltage readings are recorded for each cell on each cycle. Five-, eight-, and 10-cell packs were tested, and pack failures are shown for the 10, 11, 12, and 16 ampere-hour cells. M.W.R.

N67-19110*# Naval Ammunition Depot, Crane, Ind. Quality Evaluation Lab.
EVALUATION PROGRAM FOR SECONDARY SPACECRAFT CELLS. ACCEPTANCE TEST OF GENERAL ELECTRIC COMPANY 12.0 AMPERE-HOUR AUXILIARY ELECTRODE CELLS
E. C. Bruess Dec. 1966 27 p
(NASA Order W-11252-B)
(NASA-CR-82596; QE/C-66-803) CFSTI: HC $3.00/MF $0.65 CSCL 10A

Results of the acceptance tests of the 12 ampere-hour auxiliary electrode nickel cadmium secondary spacecraft cells are reported. It is concluded that: (1) The ceramic seals of these cells are satisfactory as evidenced by no leakers of the 30 cells tested; and (2) The capacities of the cells were in the acceptable range of 15.30 to 16.92 ampere-hours. It is recommended that the cells be accepted on the basis of the acceptance test results. S.C.W.

N67-19127*# Gulton Industries, Inc., Metuchen, N. J. Alkaline Battery Div.
DEVELOPMENT OF PILE TYPE, HIGH DISCHARGE RATE NICKEL-CADMIUM SQUIB BATTERIES Second Quarterly Report, 5 Jun.–4 Sep. 1966
S. Charlip 4 Sep. 1966 24 p
(Contract NAS5-10160)
(NASA-CR-82452) CFSTI: HC $3.00/MF $0.65 CSCL 10C

This report summarizes work and results directed toward the design and development of a pile type, nickel cadmium, squib battery. Cells with 2 square inches of active area were constructed and subjected to 10 ampere pulse discharges. The resultant voltage fell below 1.0 volts per cell. Several intermediate sizes of cells with electrode areas of 2.40, 2.76, and 3.14 square inches were constructed and tested. It was found that there is no linear relationship between current density and voltage. The larger plates showed little improvement in voltage. Cells were pulsed for 20 milliseconds to determine the presence and effects of concentration polarization and activation polarization on positive and negative electrodes respectively. A five cell battery (of 2 square inch electrodes) was assembled and tested. Sealing problems were encountered during the battery assembly. Author

N67-19150* Naval Ammunition Depot, Crane, Ind. Quality Evaluation Lab.
EVALUATION PROGRAM FOR SECONDARY SPACECRAFT CELLS ACCEPTANCE TEST OF GULTON INDUSTRIES, INCORPORATED 3.5 AMPERE-HOUR SEALED NICKEL CADMIUM CELLS WITH THE PLITT SEAL
E. C. Bruess 18 Nov. 1966 9 p
(NASA Order W-11252-B)
(NASA-CR-82574; QE/C-66-709) CFSTI: HC $3.00 CSCL 10C

Acceptance tests were performed on secondary spacecraft cells which utilize a polymerized neoprene compression seal. From the results of phenolphthalein leak, capacity, cell short, immersion, overcharge, and internal resistance tests it is concluded that the seals are satisfactory as evidenced by no leakers out of the 42 cells tested. The capacity of 41 of the cells was in the acceptable range of 3.50 to 4.38 ampere-hours while that of the remaining cell had a capacity of only 2.65 ampere-hours. A.G.O.

N67-19157*# General Electric Co., Gainsville, Fla. Battery Business Section.
CHARACTERIZATION OF RECOMBINATION AND CONTROL ELECTRODES FOR SPACECRAFT NICKEL–CADMIUM CELLS
W. N. Carson, Jr., G. Rampel, and I. B. Weinstock Oct. 1966 26 p
(Contract NAS5-10261)
(NASA-CR-82483; QR-1) CFSTI: HC $3.00/MF $0.65 CSCL 10A

Accomplishments are reported in a program to (1) develop an oxygen sensing electrode that will give a linear response to oxygen partial pressure in the range of approximately 5 to 30 psia, (2) select an oxygen recombination electrode capable of recombining the oxygen generated by the positive plate during charging, and (3) select suitable lots of negative plates for use in prototype and final cell assemblies. Oxygen sensing electrodes were fabricated with two film thicknesses of Teflon, and heat sealed to representative metallic porous and mesh type of substrates. Test cells to evaluate these sensing electrodes as a function of oxygen pressure were designed and fabricated. Test cells for the characterization of recombination electrodes were built, and electrodes of various structures and compositions were fabricated and evaluated over the operating range. Various plates were subjected to standard aerospace formation cycles, and it is reported that test cells incorporating these plates are being assembled. C.T.C.

N67-19210# European Organization for Nuclear Research, Geneva (Switzerland).
PULSED D.C. POWER SUPPLY 16 kA, 60 V SCHNEIDER–WESTINGHOUSE
H. W. Isch 20 Oct. 1966 34 p
(CERN-66-31)

The power supply for the septum magnets employed for the slow and fast ejection from the CPS straight-sections 58 and 62 is described. The power supply feeds the ejection magnets with d.c. current pulses of high stability and small ripple. Results of the tests made on the power supply are given. Author

N67-19319* Moog Servocontrols, Inc., East Aurora, N. Y.
EVALUATION PROGRAM OF MAJORITY VOTING MECHANICAL FEEDBACK SERVOACTUATOR FOR THE SATURN S-IV B, VOLUME A Final Report
I. Gusakov 22 Jul. 1966 218 p refs
(Contract NAS8-11998)
(NASA-CR-82651; MR-1080, Vol. A) CFSTI: HC $3.00 CSCL 13G

Presented are the results of an analysis of failure characteristics conducted for the S-IV B majority voting actuator evaluation program. Analysis of the system was performed to facilitate a better understanding of the majority voting characteristics on a mathematical basis and to predict the performance of the actuator under different failure regimes. A mathematical model of the system was derived and the resulting block diagram is shown. The analytical expressions which describe the system's performance under various modes of failure are given, and the restrictions on these expressions are discussed demonstrating the complexity of the calculations. Data which was obtained from the analog computer along with some actuator hardware data are also included. These data are the solutions to nonlinear equations which characterize this actuator system under the appropriate operating conditions. A.G.O.

04 BIOSCIENCES

Includes aerospace medicine, exobiology, radiation effects on biological systems; physiological and psychological factors. For related information see also: 05 Biotechnology.

N67-18203* Arkansas Univ., Little Rock. Medical Center.
SOME BIOMEDICAL APPLICATIONS OF A NON-LINEAR CURVE FIT METHOD
James W. Tyson, James H. Meade, Jr., Glenn V. Dalrymple, and Horace N. Marvin [1965] 22 p refs
(Grants NGR-04-001-014; NIH FR-200208-02; NIH FRS350-05)
(NASA-CR-81799) CFSTI: $3.00 CSCL 06C

A nonlinear curve fit method is applied to the estimation of parameters of three complex equations to illustrate its value to the biomedical investigator. The objective method does not require transformations or graphs, and can be successfully used for complex nonlinear equations. The first equation is used in hematology and pertains to the disappearance of the radioisotope Cr^{51} from the blood. The second equation from radiobiology involves irradiation of cells and their subsequent loss of ability to perform sustained and repeated mitosis. The third equation comes from biochemistry and is also termed the Michaelis–Menton equation. It gives the velocity of reaction (moles reacted/unit time) as a function of substrate concentration (moles/unit volume). The three equations are examples of equations that must be fitted by some numerical method, equations that are commonly fitted by graphical means, and equations that require transformations for linearization. It is shown that these equations can be fitted by the same basic method and use of a small digital computer system for the calculations.
S.P.

N67-18251*# California Univ., Berkeley. Space Sciences Lab.
AZOTOBACTER VINELANDII RNA POLYMERASE. II: EFFECT OF RIBONUCLEASE ON POLYMERASE ACTIVITY
Joseph S. Krakow [1965] 29 p refs Submitted for Publication
(Grant NsG-479)
(NASA-CR-69991) CFSTI: HC $3.00/MF $0.65 CSCL 06A

Experimental results are presented which support the contention that RNA polymerase is inhibited by RNA produced during RNA synthesis reactions. By using appropriately labeled substrates it was possible to assay polymerase activity by release of $32pp_i$ under conditions where accumulation of RNA production was prevented. The RNA synthesized in the presence of pancreatic RNase and T1 RNase was degraded to oligonucleotide fragments which had at best a limited ability to inhibit polymerase, so that the release of $32pp_i$ approached linearity. These findings indicate that the RNA synthesized during the course of the DNA directed reaction inhibits RNA polymerase but provide no details as to the means by which it occurs.
A.G.O.

N67-18334*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PYROLYSIS FLUORESCENCE. I: DETECTION AND ESTIMATION OF ORGANIC MATTER
P. J. Geiger, J. H. Behar, and J. H. Rho *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 147–153 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

The production and quantitation of fluorescent material from selected pure substances and natural materials are described. These include microorganisms, humic acid, and selected soils, without regard to the qualitative nature of the fluorescent materials themselves. Data on the fluorescence of a group of pyrolyzed pure and natural organic substances show that the observed peaks had essentially similar maxima, and that sensitivity could be estimated from peak heights. Figures are included to depict the fluorescence yield of pyrolyzed substances based on the number of mg of starting material; and variations of fluorescence yield with (1) temperature of pyrolysis for natural and artificial soils, (2) temperature of pyrolysis for representative materials, (3) quantity of cells pyrolized, and (4) quantity of organic matter in pyrolyzed natural soils. The results suggest that a highly sensitive, simple quantitative method is available for determining soil organic matter.
M.G.J.

N67-18335*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
FLUOROMETRIC DETERMINATION OF NUCLEIC ACIDS. II: ASSAY OF PURINES AND PURINE NUCLEOTIDES OF BIOLOGICAL SAMPLES BY CHEMICAL HYDROLYSIS
J. H. Rho *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 153–157 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

A method for the fluorescence measurement of guanine in nucleic acid hydrolyzates was modified for the microdetermination of adenine and guanine, and its application to the quantitative determination of microbial populations is considered. Also presented is a fluorometric method for quantitative microdetermination of purine ribonucleotides in ribonucleic acid hydrolyzates and in natural soil samples. Among the finding reported are: (1) The fluorometric determination of ribonucleotides produced by alkaline hydrolysis of biological samples appears to be a good method for estimating the RNA contant of a given population and, hence, the number of microorganisms. The method does not require any prior separation of purine ribonucleotides from other constituents of the hydrolyzates. (2) In determining total nucleic acids by acid hydrolysis, lower fluorescence yields in the hydrolyzates of nucleic acids are noted, as compared with those in alkaline solution. Since both adenine and guanine fluorescence in acid, the sum of adenine and guanine can be determined by this method; in alkaline solution, only guanine is determined.
M.G.J.

N67-18403# Advisory Group for Aeronautical Research and Development, Paris (France).
SOME EFFECTS OF RAISED INTRAPULMONARY PRESSURE IN MAN
J. Ernsting (Ph.D. Thesis—London Univ.) Maidenhead, England, Technivision Ltd., Oct. 1966 352 p refs
(AGARDograph-106) CFSTI: HC $3.00

The nature of the disturbances induced by raising the intrapulmonary pressure by between 30 and 140 mmHg has been investigated. Pressure breathing at these pressures distends the lungs and induces a marked alveolar hyperventilation. The application of counterpressure to the trunk reduces these effects and is essential at positive pressures greater than 40 mmHg. The use of an oronasal mask for pressure breathing allows distension of the mouth and pharynx, increased activity of the carotid baroreceptors and haemorrhages in the conjunctivae and tympanic membrane. Counterpressure to the head and neck is required at positive pressures above 65 mmHg. Raising the intrapulmonary pressure reduces the effective blood volume and collapse occurs when the reduction exceeds 700 to 800 ml. The magnitude of the reduction of effective blood volume may be decreased by applying counterpressure to the limbs but the cardiovascular disturbances induced by pressure breathing limit the time for which this manoeuvre may be used at high altitude. Provided the duration of an exposure is less than four minutes, pressure breathing with limited counterpressure will provide protection against hypoxia at altitudes of up to 70,000 ft.
Author

N67-18544* Naval Medical Research Inst., Bethesda, Md. Tissue Preservation Research Div.
STUDIES ON THE FREEZING RESISTANCE OF INTERTIDAL MOLLUSCS
Robert J. Williams [1966] 11 p Presented at the Ann. Meeting of Soc. for Cryobiology, Boston, Aug. 1966
(NASA Order R-83)
(NASA-CR-82005) CFSTI: $3.00 CSCL 06C

Studies on the whole mollusk and on tissue of common mollusk species inhabiting the temperate and subarctic coast line are reported. The *Mytilus edulis* was found able to survive at a body temperature of −10° C for extended periods of time, and the *Venus mercenaria* at a temperature only of −6° C. Both could survive exposure at lower temperatures for short periods of time, until their body temperature was reduced. Morphological changes in lethally and nonlethally frozen tissue were studied with the electron microscope, and no abnormalities were evident. Time-temperature relationships of injury from tissue freezing with and without cryoprotective agents are also described, and only DMSO was found to show promise as an agent. N.E.N.

N67-18572# Institute for Research, State College, Pa. Div. of Psychobiology.

DRUG EFFECTS UPON COGNITIVE PERFORMANCE UNDER STRESS

Paul M. Hurst and Marianna F. Weidner Aug. 1966 165 p refs

(Contract Nonr-4423(00))

(ONR-H-66-3; AD-643022) CFSTI: HC $3.00/MF $0.65

Three experiments were conducted to test an hypothesis concerning drug enhancement of performance under task-induced stress. Cognitive abilities subjected to examination were highly paced short-term memory and simple arithmetic skill. Changes in mood state, judgment of performance and perception of time passage completed the behavioral characteristics assessed. Author (TAB)

N67-18656*# Yeshiva Univ., New York.

THE EFFECTS OF SENSORY DEPRIVATION ON SENSORY, PERCEPTUAL, MOTOR, COGNITIVE, AND PHYSIOLOGICAL FUNCTIONS.

Sidney Weinstein, Milton Richlin, Marvin Weisinger, and Larry Fisher Washington, NASA, Mar. 1967 95 p refs

(Grant NsG-489)

(NASA-CR-727) CFSTI: HC $3.00/MF $0.65 CSCL 06S

Investigated were human sensory, perceptual, and physiological mechanisms under sensory deprivation by observing a broad spectrum of behaviors from the cognitive to the sensory and motor, along with measures of physiological and metabolic functions. Deprivation took a variety of forms: in two studies the subjects were deprived of tactual sensation alone, and in the third study they were deprived of visual, auditory, and tactual sensations. Subjects were individually isolated for up to 72 hours. Results showed that except for absolute pressure sensitivity on the palm, sensory thresholds were unaffected by deprivation. G.G.

N67-18701# Southwest Research Inst., San Antonio, Tex. Dept. of Physical and Biological Science.

A STUDY OF CALCIUM, PHOSPHORUS AND NITROGEN MOBILIZATION RESULTING FROM CONDITIONS OF INACTIVITY Final Report

Arthur L. Gross, Kenneth T. Roberson, Louis H. Krough, Jr., and John W. Miesse 30 Jun. 1966 114 p refs

(Contract AF 41(609)-2749) CFSTI: HC $3.00/MF $0.65

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APPENDIXES

4. COMPARATIVELY RAPID ANALYTICAL PROCEDURE FOR ANALYSIS OF CALCIUM, NITROGEN AND PHOSPHORUS IN BODY FLUIDS, FECES AND FOOD SAMPLES K. T. Roberson, A. L. Gross, L. H. Krough, Jr., and J. W. Miesse 2 p (See N67-18702 08-04)

5. CALCIUM, NITROGEN AND PHOSPHORUS MOBILIZATION RESULTING FROM INACTIVITY A. L. Gross, L. H. Krough, Jr., J. W. Miesse, and K. T. Roberson 82 p (See N67-18703 08-04)

N67-18702# Southwest Research Inst., San Antonio, Tex. Dept. of Physical and Biological Science.

COMPARATIVELY RAPID ANALYTICAL PROCEDURE FOR ANALYSIS OF CALCIUM, NITROGEN AND PHOSPHORUS IN BODY FLUIDS, FECES AND FOOD SAMPLES

Kenneth T. Roberson, Arthur L. Gross, Louis H. Krough, Jr., and John W. Miesse *In its* Study of Calcium, Phosphorus and Nitrogen Mobilization Resulting from Conditions of Inactivity 30 Jun. 1966 2 p (See N67-18701 08-04) CFSTI: HC $3.00/MF $0.65

Consideration is given to the daily calcium, nitrogen, and phosphorus balance of monkeys in various conditions of inactivity. The analytical method developed allowed the determination of these materials from a single perchloric acid digestion. It is noted that this procedure has proven to be very reliable and simple for the determination of large numbers of samples. A.G.O.

N67-18703# Southwest Research Inst., San Antonio, Tex. Dept. of Physical and Biological Science.

CALCIUM, NITROGEN AND PHOSPHORUS MOBILIZATION RESULTING FROM INACTIVITY

Arthur L. Gross, Louis H. Krough, Jr., John W. Miesse, and Kenneth T. Roberson *In its* Study of Calcium, Phosphorus and Nitrogen Mobilization Resulting from Conditions of Inactivity 30 Jun. 1966 82 p (See N67-18701 08-04) CFSTI: HC $3.00/MF $0.65

Immobilization effects were studied by following calcium, phosphorus, and nitrogen balances in monkeys that were inactivated for periods as long as eight weeks. Methods of immobilization used were surgical denervation, tranquilization, and plaster casts. The results of the balance studies indicate that there is no apparent loss of calcium but that there is a marked increase in the urinary excretion of phosphorus with a concomitant decrease in fecal excretion of phosphorus resulting in no net loss. Animals immobilized by means of plaster casts and denervation exhibited a marked negative nitrogen balance. A.G.O.

N67-18723*# California Univ., Los Angeles. Brain Research Inst.

COMPUTER ANALYSIS OF EEG DATA FOR NORMATIVE LIBRARY Final Report, Sep. 24, 1963–Jan. 31, 1966

J. D. French, W. R. Adey, and D. O. Walter 15 Apr. 1966 191 p refs

(Contract NAS9-1970)

(NASA-CR-65578) CFSTI: HC $3.00/MF $0.65 CSCL 06B

Intensity of activity, mean frequency, equivalent band-width, and coherence values in four frequency ranges ("$\delta, \theta, \alpha, \beta$") were calculated for four channels of EEG recorded from each of four normal adult human males, in five experimental situations, including periods of rest and of attention. Stepwise discriminant analysis was applied to the calculated values for all subjects, simultaneously, to develop formulas for automatic categorization of records into the situation in which they were recorded. After selecting only four parameters, the program correctly categorized 49% of the records; the erroneous categorizations were mainly into related situations. When the records from each subject were separately analyzed, a higher proportion of records was correctly categorized; the parameters chosen were only partially overlapping with those chosen for the simultaneous discrimination. Thus an objective method of identifying parameters of the EEG which are important in distinguishing subjects' responses to differing situations has shown its value for developing criteria applicable to many individuals; it has also shown that individuals differ substantially in the list of parameters most distinguishing for their own records. Author

N67-18922*# National Aeronautics and Space Administration, Washington, D. C.

HISTOLOGICAL CHANGES IN THE INNER EAR OF ANIMALS EXPOSED TO X-IRRADIATION [GISTOLOGICHESKIYE IZMENENIYA VO VNUTRENNEM UKHE ZHIVOTNYKH POD-VERGNUTYKH RENTGENOVSKOMU OBLUCHENIYU]

N. I. Ivanov Nov. 1966 9 p refs Transl. into ENGLISH from Vestn. Otorinolaringol. (Moscow), v. 18, 1957 p 78–83

(NASA-TT-F-10497) CFSTI: HC $3.00/MF $0.65 CSCL 06R

Following X-irradiation (either general or local exposure) of rabbits and guinea pigs in the region of the ear, the animals were kept under observation for some time and then killed. The X-ray doses used (total local dose: 2×1000 R, R, total general dose: 300 or 600 R) induced traumatic effects as well as pathologic changes in the middle and inner ears of these animals. The organ of Corti was the most sensitive to X-ray. Reaction to the traumatic effect could clearly be noted as labyrinthitis. Author

N67-18931*# National Aeronautics and Space Administration, Washington, D. C.

EVOLUTION OF THE CATALYTIC FUNCTION OF THE GLUTAMATE OXIDASE SYSTEM [EVOLYUTSIYA KATALITICHESKOY FUNKTSII GLUTAMATOKSIDAZNOY SISTEMY]

L. P. Zubok, and Z. S. Kagan Jan. 1967 7 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR, Ser. Biokhimiya (Moscow), v. 166, no. 4, 1966 p 982–985

(NASA-TT-F-10679) CFSTI: HC $3.00/MF $0.65 CSCL 06A

Measurements were made of the activation energy for oxidation of glutamic acid by the enzyme systems of Rickettsia prowazekii, by E. Coli, by healthy mouse tissues, and by the tissues of mice infected with Rickettsia prowazekii. The results are discussed in terms of the evolution of the enzyme systems. Author

N67-18932*# National Aeronautics and Space Administration, Washington, D. C.

THE EFFECT OF DENATURATION OF PROTEINS ON THEIR COACERVATION WITH DYES [VLIYANIYE DENATURATSII BELKOV NA KONTSENTRATSIYU IKH S KRASITELYAMI]

N. L. Fel'dman Jan. 1967 6 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR, Ser. Fiziologiya (Moscow), v. 74, no. 6, 1950 p 1139–1142

(NASA-TT-F-10681) CFSTI: HC $3.00/MF $0.65 CSCL 06A

Frog serum and horse serum as well as serum albumen and egg albumen are used to study the effect of denaturation on the coacervation capacity of proteins so as to determine if cessation of granule formation results from denaturation charges in damaged cells which prevent coacervation. Among factors inducing denaturation the author studied acetone, temperature, ultraviolet rays and urea. It was found that urea in no way effects coacervation. Denaturation changes prohibit protein from entering into a coacervation reaction with dyes or other substances. Therefore, granule formation in an injured cell may cease due to denaturation of protoplasm proteins resulting from disruption in the metabolism. Author

N67-18936*# National Aeronautics and Space Administration, Washington, D. C.

THE PHOTOSENSITIZING ACTIVITY OF CHLOROPHYLL IN COACERVATES [FOTOSENSIBILIZIRUYUSHCHAYA AKTIVNOST' KHLOROFILLA V KOATSERVATAKH]

K. B. Serebrovskaya, V. B. Yevstigneyev, V. A. Gavrilova, and A. I. Oparin Feb. 1967 11 p refs Transl. into ENGLISH from Biofizika (Moscow), v. 7, no. 1, 1962 p 34–41

(NASA-TT-F-10711) CFSTI: HC $3.00/MF $0.65 CSCL 06A

Coacervates containing chlorophyll are derived from serum albumin and potassium oleate in 50% alcohol. Experiments with coacervates having a definite chlorophyll content showed that the photosensitizing activity in the coacervate, chlorophyll containing drops is significantly higher than in the surrounding liquid, which also contains chlorophyll. This paper presents some considerations to explain this phenomenon. Author

N67-18938*# National Aeronautics and Space Administration, Washington, D. C.

RESISTANCE OF CERTAIN STRAINS OF MICROORGANISMS TO ULTRAVIOLET RAYS [USTOYCHIVOST NEKOTDRYKH SHTAMMOV MIKROORGANIZMOV K DEYSTVIYU UL'TRA-FIOLETOVYKH LUCHEY]

A. I. Zhukova and V. Kh. Kozlova Feb. 1967 7 p refs Transl. into ENGLISH from Mikrobiologiya (Moscow), v. 35, no. 2, 1966 p 320–306

(NASA-TT-F-10720) CFSTI: HC $3.00/MF $0.65 CSCL 06M

The critical uv dose for 28 strains of microorganisms was evaluated. The aim was to select species suitable for experiments under Martian conditions. The most resistant to uv appear to be nonpigmented spore forming bacteria and nonsporeforming yeast possessing pigments of intensive colorations (black, red). Microbial activity in the surface layers of the Martian soil seems to be quite probable judging from the data obtained. Author

N67-18939*# National Aeronautics and Space Administration, Washington, D. C.

CHANGES IN NERVE CELLS AS A RESULT OF THE ACTION OF IONIZING RADIATION [IZMENENIYA V NEYRONAKH PRI VOZDEYSTVII IONIZIRUYUSHCHEGO IZLUCHENIYA]

A. D. Smirnov Jan. 1967 7 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR, Ser. Biofiz. (Moscow), v. 131, no. 5, 1960 p 1171–1173

(NASA-TT-F-10723) CFSTI: HC $3.00/MF $0.65 CSCL 06R

The author conducted a histomorphological analysis of various central nervous system structures from roentgen-irradiated (500r) dogs. Three figures show histological changes in various neural tissues caused by irradiation. The mechanisms of these changes are discussed. The conclusion drawn from this study was that histomorphological changes in the nervous system reflect its sensitivity to ionizing radiation. Injury to neurons of the vasomotor reflex arc should be considered relative to the general pathogenesis of radiation sickness and the hemorrhagic syndrome as reflecting disruption of vascular wall trophics. Author

N67-18940*# National Aeronautics and Space Administration, Washington, D. C.

BIOCHEMICAL EFFECTS OF STATIC ELECTRICITY DURING GORDON'S EVA [BIOCHEMISCHE WIRKUNGEN DER STATISCHEN ELEKTRIZITAT INNERHALB DES WELTRAUMSPAZIERGANGES HERRN GORDONS]

Stefan Molnar Jan. 1967 7 p Transl. into ENGLISH from German

(NASA-TT-F-10725) CFSTI: HC $3.00/MF $0.65 CSCL 06A

The author reports his experiences with static electricity in his practice and details his theory attributing Gordon's enervation in his space walk to accumulated frictional static electricity. This electricity can impede cell respiration and produce a neuroallergic shock effect due to damaged cells. Author

N67-18941*# National Aeronautics and Space Administration, Washington, D. C.

A STUDY OF HISTONE ACTION ON SYNTHESIS OF ANTIBODIES AND OTHER CELLURLAR PROTEINS *IN VITRO* [IZUCHENIYE DEYSTVIYA GISTONOV NA SINTEZ ANTITEL I DRUGIKH KLETOCHNYKH BELKOV *IN VITRO*]

Ye. V. Sidorova Feb. 1967 14 p refs Transl. into ENGLISH from Biokhimiya (USSR), v. 31, 1966 p 789–798

(NASA-TT-F-10727) CFSTI: HC $3.00/MF $0.65 CSCL 06A

The influence of different histones on the synthesis of antibodies and other proteins in rabbit's spleen cell culture during the secondary response *in vitro* has been investigated. The synthesis of antibody and non-specific γ-globulin was determined by measuring the specific increase of C^{14}-activity on immunosorbents; the synthesis of other water-soluble proteins–as C^{14}-incorporation into TCA-precipitate. It was shown that histones (20–30 γ/ml) inhibited the synthesis of antibodies of non-specific γ-globulins and of other proteins to 20–50%. The synthesis of antibody and of non-specific γ-globulin was inhibited at the same degree, but the formation inhibition of water-soluble protein was much less expressed. Different histone fractions possessed different inhibiting activity. The action of all histone fractions was proportional to its concentration. Author

N67-18963*# Texas Inst. for Rehabilitation and Research, Houston.
A STUDY OF THE POSSIBLE PREVENTIVE EFFECTS OF MUSCULAR EXERCISES AND INTERMITTENT VENOUS OCCLUSION ON THE CARDIOVASCULAR DECONDITIONING OBSERVED AFTER 10 DAYS BED RECUMBENCY: EXPERIMENTAL DESIGN
David Cardus, Willis C. Beasley, and Fred B. Vogt Washington, NASA, Feb. 1967 173 p refs
(Contract NAS9-1461)
(NASA-CR-692) CFSTI: HC $3.00/MF $0.65 CSCL 06S

An experimental program designed to study the efficacity of exercise and/or intermittent leg cuff inflation in preventing cardiovascular deconditioning is described. Consideration is given to the experimental subjects participating in the study, the planning and conditions of the experiments, the methods and techniques of physiological and psychological testing, and the general procedure of data handling. A.G.O.

N67-19001# Oak Ridge National Lab., Tenn.
THE BIOCOENETIC PROCESS IN AN ESTUARINE PHYTOPLANKTON COMMUNITY
B. C. Patten Oct. 1966 106 p refs
(Contract W-7405-ENG-26)
(ORNL-3946) CFSTI: HC $3.00/MF $0.65

An ecological theory of adaptation at the community level of organization is developed. By adaptation is meant the establishment of optimum relationships between structure and function for community life under existing or expected conditions of environment. An analog computer model of a hypothetical food chain is explored to elucidate how structure–function relationships in coupled systems are determined by the communication net, or pattern of coupling between the parts. Since optimization necessarily implies input of information from the environment which details, in effect, how far off the present state of the system is from an optimum state, there is implicit in the adaptation process a kind of community cognition. To give emphasis to this aspect etymologically, the process of community adaptation is referred to as biocoenesis. An annual cycle of structure–function relationships in phytoplankton of the York River, Virginia, is described, with particular emphasis on aspects which relate to system adaptability. Author (NSA)

N67-19048*# Pittsburgh Univ., Pa. Graduate School of Public Health.
NO TITLE Quarterly Progress Report, 1 Oct.–31 Dec. 1966
Niel Wald 20 Feb. 1967 11 p
(Contract NASr-169)
(NASA-CR-82522; QPR-12) CFSTI: HC $3.00/MF $0.65 CSCL 06B

The status of a project to extend the usefulness of cytogenetic methodology as a research technique and as a biomedical monitoring procedure is presented. Efforts are focused on the utilization of automatic electronic scanning and computer analysis of chromosomes. Design of an automatic microscope is described, and the preparation of a computer for its function as the control system for the automatic microscope and the flying spot scanner is related. S.P.

N67-19049*# Naval Medical Research Inst., Bethesda, Md. Tissue Preservation Research Lab.
NO TITLE Final Report
[1966] 6 p
(NASA Order R-63)
(NASA-CR-82523) CFSTI: HC $3.00/MF $0.65 CSCL 06F

Research was conducted on the relationship between cell injury and ice crystal growth as well as between injury and dehydration, in order to understand the mechanism by which freezing injuries can be prevented by cryoprotective agents. The intertidal mollusk (*Mytilus edulis*) was selected as an experimental subject since they are the largest and most highly developed organisms which show a natural resistance to freezing injury. The consensus, after examination by electron microscopy, thermal analysis, and calorimetric methods, was that injury following flow freezing with extracellular ice is almost always the result of dehydration, not mechanical injury from crystallization. Only in the special case of ultra-rapid freezing with intracellular ice does there appear to be a mechanical element, probably often superimposed on a dehydration injury. R.U.

N67-19086* Public Health Service, Cincinnati, Ohio.
ECOLOGY AND THERMAL INACTIVATION OF MICROBES IN AND ON INTERPLANETARY SPACE VEHICLE COMPONENTS Quarterly Progress Report, 1 Oct.–31 Dec. 1966
Robert Angelotti Jan. 1967 12 p refs
(NASA Order R-36-015-001)
(NASA-CR-82514) CFSTI: $3.00 CSCL 06M

Methods have been developed for incorporating and recovering *B. subtilis* var. *niger* spores in epoxy resin and preliminary data indicate that D value in comparison to Lucite may be twice as great in this type of plastic. A system has been developed for measuring the thermal resistance of spores on stainless steel metal surfaces and preliminary data indicate that D values will be much less for spores so located than for spores encapsulated in Lucite. Measurements of the thermal resistance of spores adjusted to various levels of water activity prior to encapsulation in Lucite indicate that water activity may be significant consideration in establishing dry heat sterilization processes. Author

N67-19068 Royal Aircraft Establishment, Farnborough (England).
THE PROBLEM OF THE PENETRABILITY OF BIRDS WINGS (EXPERIMENTAL STUDIES OF BIRD FLIGHT) [K VOPROSU O PRONITSAEMOSTI KRYLA PTITS]
G. S. Shestakova Dec. 1965 26 p refs Transl. into ENGLISH from Tr. Inst. Morfol. Zhivotn., Akad. Nauk SSSR (Moscow), v. 9, 1953 p 14–30
(RAE-LIB-TRANS-1143) CFSTI: $3.00

Over 200 experiments were conducted on a variety of hand reared birds to determine the effects of various wing phenomena on the flight of birds. The method used was to restrict a particular aspect of the wing mechanism and to observe the effect on the bird's flight. The experiments consisted of eliminating slots between flight feathers, eliminating slots between primary feathers, eliminating slots between secondary feathers, cutting away the alula or bastard wing, enlarging slots between flight feathers, cutting away some of the covert feathers, and artificial shortening of parts of the wing. The study concluded that a bird wing does not always act as an unbroken carrying surface. It has a slotted structure in which there is fissuring of the sing apex and there are slots between secondary feathers. The slotted structure of the wing is a mechanism for increasing lift and is only used in certain flight modes. The bastard wing is part of the slot mechanism and is

used to increase lift. In many birds there is a penetrability in the cambered part of the wing in the root region of the secondary feathers which may be linked to aquintocubitalism. Author

N67-19090* Indiana Univ., Bloomington. Dept. of Anatomy and Physiology.
THE DISTRIBUTION OF BLOOD LACTATE AND PYRUVATE DURING WORK AND RECOVERY, PART V Final Scientific Report
J. L. Newton and S. Robinson 31 Dec. 1966 16 p refs
(Grant NsG-408)
(NASA-CR-82508) CFSTI: $3.00 CSCL 06S

The distribution of blood lactate and pyruvate were studied in man walking on the treadmill (VO_2 1.9 1/min) for 14 minutes, and in other experiments running to exhaustion in 5 minutes. Blood samples were drawn from the femoral and antecubital veins and from the radial artery at frequent intervals during work and recovery. During the exhausting runs femoral and arterial blood lactates rose rapidly to values 1 1/2 times corresponding values in the antecubital vein where the increase was much slower; arterial and femoral blood pyruvates rose much more slowly and were only slightly higher than those in the antecubital vein. The blood lactate concentrations at these three locations did not reach equal values until 5 to 20 minutes after work. These differences in concentrations at the three locations indicate the degree of error involved in estimating total body lactate from blood samples drawn at any one, or even simultaneously from all 3 of these locations during work and early recovery. Mechanisms of the variations are discussed. Author

N67-19099*# Naval Medical Research Inst., Bethesda, Md.
THE RELATIONSHIP BETWEEN DEHYDRATION AND FREEZING INJURY IN THE HUMAN ERYTHROCYTE
Harold T. Meryman [1966] 27 p refs Presented at the Low Temp. Sci. Conf., Sapporo, Japan, Aug. 1966
(NASA Order R-63)
(NASA-CR-82487) CFSTI: HC $3.00/MF $0.65 CSCL 06C

Studies were conducted which demonstrated that dehydration is the primary cause of freezing injury in human erythrocytes. A model is presented whereby the varying effects of slow and rapid freezing, penetrating and non-penetrating cryoprotective agents, and intracellular crystallization can be explained on the basis of their effects on hydration. Evidence is also given that the hemolysis of erythrocytes with freezing does not appear to be related to the total residual liquid phase as would be expected if solute concentration or the simple filling of interstitial spaces were the primary factor in survival following freezing. The concept of water essential to protein stability is found to be incompatible with the protective effect of cryoprotective agents unless they are presumed to substitute or stabilize for water in cases the effectiveness of a cryoprotective agent will depend on its ability to make this substitution rather than simple "antifreeze" properties. R. N.A.

N67-19102*# New England Medical Center Hospitals, Boston, Mass.
BIOMAGNETISM AND FERRITIN Final Report
Peter W. Neurath and Ellen G. Sloane 30 Jan. 1967 7 p
(Grant NGR-22-021-002)
(NASA-CR-82653) CFSTI: HC $3.00/MF $0.65 CSCL 06C

Continued studies focusing on the determination of the iron content in embryos of *Rana pipiens* are reported. A micro method for determining the iron content of frog embryos and sections of frog embryos using bathophenanthroline was developed. The method will allow the determination of as little as 0.1 g of iron, 1/10th the total of the average iron content of an egg. A survey of the distribution of iron in the frog embryos, Shumway stages 3 and 20, the sections of these consisting of approximately one-half of the egg was initiated. Results confirm that embryos on the average contain about 1 microgram of iron. No conclusions were drawn as to the variation in the results from embryo to embryo and from one-half of an embryo to another. Further tests with the electron probe of ferritin containing rat intestine sections did not indicate the ability of this method to see ferritin. S.C.W.

N67-19103*# Pennsylvania State Univ., University Park. Physiology-Biophysics Labs.
A CYTOPHOTOMETRIC ANALYSIS OF ANTERIOR PITUITARY CHANGES IN RATS EXPOSED TO REDUCED PRESSURE
Kenneth Rockwell (Ph.D. Thesis) and Adam Anthony Mar. 1967 96 p refs
(Grants NGR-39-009-015(2); NIH GM-05112)
(NASA-CR-82668) CFSTI: HC $3.00/MF $0.65 CSCL 06F

Reported is a study designed to describe the adaptive cytochemical responses of the hormone producing cells of the rat anterior pituitary following exposure of varying duration to simulated high altitude. All data were obtained by application of differential cell count and analytical cytophotometric techniques. Data from differential cell counts of stained tissue sections showed that all chromophil cell types increased in relative number within 49 hours or less of the onset of altitude exposure. Chromophobe cells decreased in relative number in a similar manner. Since no mitotic figures were observed, it was concluded that altitude induced changes in relative anterior pituitary chromophil cell numbers did not represent true hyperplasia. Cytophotometric characterization of anterior pituitary chromophic cells of each type was shown to be possible using a Leitz microspectrophotometer. The similarities in absorption spectra obtained from the stained cytoplasm of individual cells of each type in both control and altitude exposed rats demonstrated that hypoxia did not cause cytochemical alterations of any kind in the hormone products stored by respective chromophils. Quantitative evaluation of the cytophotometric data indicated that the relative intensity of cytoplasmic staining increased in acidophil cells, and gonadotropic and thyrotropic basophils during altitude acclimation. It was concluded that such increases in dye-binding capacity resulted from increased intracellular hormone storage. S.C.W.

N67-19107*# Florida State Univ., Tallahassee. Dept. of Statistics.
ESTIMATION OF THE PARAMETERS IN EXPONENTIAL DECONTAMINATION MODELS
Richard G. Cornell 1 Feb. 1967 15 p refs
(Grant NGR-10-004-029)
(NASA-CR-82663; TR-8) CFSTI: HC $3.00/MF $0.65 CSCL 06M

Reported are results of a study concerned with the estimation of parameters in decontamination models based upon the assumption that the probability, p_t, that a single microorganism is alive at time t in a given environment is of the form $p_t = \mu^t$. Analyzed are methods of estimation for models derived from the proposed assumption. The discussion of decontamination probability models and estimation procedures emphasizes the need for further research on the statistical aspects of microbial assay. The presentation of models includes discussion of possible alternative models and alludes to the fact that the statistical literature already contains considerable work on such models. Reference is also made to the need for estimation techniques. A summary of research underway or planned for the future on the statistical aspects of microbial assay is included. S.C.W.

N67-19149*# Naval School of Aviation Medicine, Pensacola, Fla.
MEASUREMENTS OF THE ASTRONAUTS' RADIATION EXPOSURE WITH NUCLEAR EMULSION ON MERCURY MISSIONS MA-8 and MA-9

Hermann J. Schaefer and Jeremiah J. Sullivan 25 May 1964 17 p refs
(NASA-CR-82574; Rept.-27) CFSTI: HC $3.00/MF $0.65 CSCL 06R

Findings are presented from a post-flight record of radiation exposure of the astronauts during missions Ma-8 and MA-9. Closer attention to the radiation exposure was called for because these two missions took place within one year after the high altitude nuclear explosion known as the Starfish Test. Another problem concerned the additional exposure in the South Atlantic Anomaly, a region where the Inner Van Allen Belt dips down more deeply than at any other longitude due to certain irregularities in the earth's magnetic field structure. Emulsions flown on MA-8 and MA-9 showed a background from electrons and gamma rays not significantly different from that of the sea level controls, indicating that the inherent shielding of the capsule was sufficient for complete absorption of electrons from the artificial radiation belt. This important result shows that the primary cosmic ray beam produces, in one and a half tons of compact material of the Mercury capsule, only an insignificant amount of electrons and gamma rays. A.G.O.

N67-19158*# IIT Research Inst., Chicago, Ill.
LIFE IN EXTRATERRESTRIAL ENVIRONMENTS Quarterly Status Report, Nov. 15, 1966–Feb. 15, 1967
Charles A. Hagen 15 Feb. 1967 18 p
(Contract NASr-22)
(NASA-CR-82484; IITRI-L6023-8) CFSTI: HC $3.00/MF $0.65 CSCL 06M

Results are presented from simulated Martian environment experiments conducted with *Staphylococcus aureus*. The effects of various barometric pressures and carbon dioxide growth were studied over a 56 day period. Growth of *S. aureus* was rapid and abundant in Earth atmospheres at barometric pressures of 10, 25, and 40 mb. Carbon dioxide concentrations of 37, 67, and 100% at pressures of 40, 25, and 10 mb respectively, did not adversely affect the growth, although the population maxima were slightly lower than the Earth atmosphere maxima. An 8-hr daily freeze lowered the minimum water requirement for growth of *S. aureus* below that required for growth at constant 35°C. A.G.O.

N67-19202# Royal Aircraft Establishment, Farnborough (England).
THE STRUCTURE OF THE WING SURFACE AND ITS SIGNIFICANCE IN THE AERODYNAMICS OF BIRDS [STRUKTURA POVERKHNOSTI KRYLA I EE ZNACHENIE DLYA AERODINAMIKI]
G. S. Sheetakova Dec. 1965 41 p refs Transl. into ENGLISH from Tr. Inst. Morfol. Zhivotn. Akad. Nauk SSSR (USSR), v. 9, 1953 p 32–58
(RAE-LIB-TRANS-1142) CFSTI: HC $3.00/MF $0.65

This article describes the structure of a bird's wing, with particular attention being paid to the way in which the feathers overlap each other. Each type of feather in the wing surface is considered and its relationship with its neighbor indicated. The shape and cross-section of each feather group is illustrated. The micro-structure of feathers is detailed and the variation on different sections of feathers is pointed out. The distribution of direction of the barbs over the entire wing surface is illustrated, and a hypothesis is introduced relating the direction of the barbs with the deflection of the airstream over the wing. The hypothesis is also advanced that the additional roughness on the underside of the wing surface reduces the velocity of the air passing below the wing and thus increases the differential velocity between the upper and lower surfaces which should increase the lift obtained. Aerodynamic problems of feathered flight are also considered. Author

N67-19207# Portugal. Nuclear Energy Commission, Sacavem.
INTERFERENCE OF RADIATIONS IN THE CUPRO-OXIDASIC ACTIVITY [INTERFERENCIA DAS RADIACOES NA ACTIVIDADE CUPRO-OXIDASICA DO SORO HUMANO]
J. P. Galvao, E. M. Magalhaes, F. P. Teixeira, and M. H. Matos 1966 11 p refs Presented at the 1st Congr. of the Brasileiro de Radiologia, Luso, Rio de Janeiro, 12–18 Sep. 1965 In PORTUGUESE
(Doc.-LFEN-57A) CFSTI: HC $3.00/MF $0.65

Several researchers observed that the ultraviolet radiation action on human serum causes a decrease of its oxidasic activity in the presence of paraphenylene diamine, *in vitro*. To study this activity of possible interest to the field of radiobiology, *in vitro* human serum was subjected to X-ray and gamma radiations. Transl. by R.Ll.

N67-19208 Institute for Perception RVO–TNO, Soesterberg (Netherlands).
SOME ASPECTS OF REACTION PROCESSES
A. F. Sanders [1966] 30 p refs
(IZF-1966-8; TDCK-46511) CFSTI: HC $3.00

Research on reaction processes is discussed. Data indicate that reactions are based upon a number of successive internal responses. One of the first may be labelled the elementary code, which is afterwards translated in response terms. If the response directly corresponds with the elementary code, the situation has an extremely high S–R compatibility and CRT becomes independent from the number of alternative signals. The translation stage of the reaction is thought to be dependent on information and appears to be also the most critical stage in handling information. Some experiments are reported showing that two successive responses to one signal, a compatible and an incompatible, do not interfere with each other while two incompatible responses do. It is therefore surmised that a compatible response seems to be a station which is naturally passed when the S–R combination is incompatible. Data on information condensation, expectation, and the statistical decision theory of reaction time are also included. Author

N67-19216*# Illinois Univ., Urbana.
THE PHYSICAL AND CHEMICAL PROPERTIES OF HUMAN SWEAT AND FACTORS AFFECTING THE WATER BALANCE IN CONFINED SPACES Semi-Annual Status Report, No. 3, 1 Jul.–31 Dec. 1966
Robert E. Johnson and Frederick Sargent, II 31 Dec. 1966 61 p refs
(Grant NGR-14-005-050)
(NASA-CR-82590; SASR-3) CFSTI: HC $3.00/MF $0.65 CSCL 06S

Reported are results of a study on the relationship between the rate of sweating and the chemical composition of sweat in humans, and results of a comparative study of the chemical composition of sweat collected in impermeable bags on the arms and sweat simultaneously produced naturally without the interposition of an impermeable capsule. The following regularities were observed during studies of the relation between rate of sweating and chemical concentration in glove sweat: rises in osmolarity, Na, Cl, and pH with increased rate of sweating. Lactate, Mg, Ca, NH_3, and total N all diminished. Urea and creatinine did not change regularly, and the sweat was always hypotonic to blood plasma. Correlations between total body sweat and glove sweat were good. Dermal losses of water, Na, K, NH_3, Cl, lactate, urea, total N, and total osmols were of the same order of magnitude for total body and glove sweat when expressed on the basis per square meter of skin and hour. It is concluded that glove sweat can be used to predict total body sweat with respect to the substances measured except for Mg and Ca. An improved method for measuring oxygen consumption and carbon dioxide production in man is described. S.C.W.

N67-19223# Keio Univ., Tokyo (Japan). School of Medicine.
MECHANISMS SUBSERVING COLOR CODING IN THE VERTEBRATE RETINA Final Report, Oct. 1965–Oct. 1966
Tsuneo Tomita Dec. 1966 28 p refs /ts Rept.-4
(Grant DA-CRD-AG-S92-544-65-G31)
(J-228-4; AD-644493) CFSTI: HC $3.00/MF $0.65

Intracellular recording from single cones in the carp (Cyprinus carpio) is an attempt to clarify the mechanism of color information processing in vertebrate photoreceptors. As the only means to permit the intracellular recording, the retina detached from the pigment epithelium is jolted at a high acceleration against a vertically held, slowly advancing micropipette. The new model of jolting device is described. Whenever a potential identified as a single cone potential is found, the visible spectrum adjusted to equal quantum flux is scanned by means of a photostimulator especially built for this experiment and the single cone spectral response curve is obtained. Statistical analysis of 142 records selected out of hundreds, based solely on the greatest signal-to-noise ratio, reveals three groups of cones: the red cones (74%) with the average peaking wavelength at 611 millimicrons, green cones (10%) at 529 millimicrons, and blue cones (16%) at 462 millimicrons. These peaking wavelengths are in close accord with those of single cone absorption spectra measured by Marks and MacNichol in the goldfish by a microspectrophotometer. It is strongly suggested that Young's trichromatic theory applies at the photoreceptor level in the vertebrate. Author (TAB)

N67-19230# Library of Congress, Washington, D. C. Aerospace Technology Div.
HEMODYNAMIC INDICES DURING THE ACTION OF SUPER-HIGH FREQUENCY ELECTROMAGNETIC FIELDS Surveys of Foreign Scientific and Technical Literature
A. M. Monayenkova and M. N. Sadchikova 5 Oct. 1966 8 p refs Transl. into ENGLISH from Gigena Truda i Prof. Zabolevaniya (Moscow), no. 7, 1966 p 18–21
(ATD-T-66-123; TT-67-60346; AD-644533) CFSTI: HC $3.00/MF $0.65

Analysis of the data yielded by clinical and physiological studies of the cardiovascular system did not permit establishment of a firm correlation between hemodynamic disorders and pathological deviations due to SHF exposure. However, subchanges in hemodynamic indices were found to occur much more frequently. Author (TAB)

N67-19231# Naval Radiological Defense Lab., San Francisco, Calif.
APPARENT ABSENCE OF RECOVERY IN ENDOGENOUS COLONY-FORMING CELLS AFTER IRRADIATION UNDER HYPOXIC CONDITIONS
Theodore L. Phillips and Gerald H. Hanks 24 Oct. 1966 35 p refs
(USNRDL-TR-1086; AD-644117) CFSTI: HC $3.00/MF $0.65

Groups of LAF sub 1 adult mice were subjected to both graded and divided doses of radiation under hypoxic conditions and in air. The endogenous spleen colony-forming unit technique was used to measure the effect of the irradiation on survival of the colony-forming cells. Dose-response curves indicated a D sub 0 of 122 rads in air and 273 rads under hypoxic conditions, an oxygen enhancement ratio of 2.2. Using 2 doses each of 315 rads in air and of 830 rads under hypoxia, survival ratios were obtained for times between 3 and 36 hours. Animals irradiated in air show peaks in the survival ratio at 9 and at 27 hours. The initial peak is probably the result of early repair within the cell and the second peak that of onset of regeneration. The survival ratio of the animals irradiated under hypoxic conditions was not increased but rather fell slightly at times following the initial point. The results suggest that the degree of early cellular repair is markedly decreased and the onset of proliferation is delayed when radiation injury occurs under conditions of hypoxia. Author (TAB)

N67-19258# Institute for Perception RVO–TNO, Soesterberg (Netherlands).
MONOCULAR AND BINOCULAR AFTEREFFECTS OF CHROMATIC ADAPTATION
R. L. de Valois and J. Walraven 1966 12 p refs Sponsored in part by NSF
(IZF-1966-9; TDCK-46510) CFSTI: HC $3.00/MF $0.65

Supersatured greens seen after long-wavelength adaptation depends upon contrast from the continuing after discharge of bleached "red" receptors in the surrounding area, rather than upon inactivation from bleaching of "red" receptors in the test spot area. When test spot and bleach field coincide spatially, supersatured greens are not seen. When the test field is presented in the other eye at a corresponding place, the green looks unsaturated. Here, however, no influence of the size of the bleaching field is found. This means that the color contrast effect does not occur binocularly. Color contrast must therefore be a retinal phenomenon. Author

05 BIOTECHNOLOGY

Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation, and piloting. For related information see also: 04 Biosciences.

N67-18293# Dynatech Corp., Cambridge, Mass.
A STUDY OF WATER AND CARBON DIOXIDE PRECIPITATION TECHNIQUE USING THERMAL RADIATION PRINCIPLES Technical Report, 1 Jul. 1965–20 Jun. 1966
Jacques M. Bonneville Wright-Patterson AFB, Ohio, AMRL, Aug. 1966 76 p refs
(Contract AF 33(615)-2950)
(AMRL-TR-66-118; AD-643326) CFSTI: HC $3.00/MF $0.65

Various freeze-out techniques, conceived for controlling carbon dioxide and water vapor in a manned space enclosure in earth orbit, were investigated, analyzed and evaluated. Carbon dioxide elimination presents a much greater problem than does water vapor elimination. The system selected has the following main characteristics: a separate air loop for each vapor; simultaneous sublimation and precipitation in each loop; the freeze-out plate, sublimator, radiator, and second stage heat exchanger in the carbon dioxide loop, are integral and outside the cabin; in an equatorial orbit, the radiator is sun-shielded by a fixed-attitude, open-ended cover. Author (TAB)

N67-18398*# Northrop Space Labs., Hawthorne, Calif.
DEVELOPMENT OF AN INTERNAL RESTRAINT SYSTEM FOR AN INTEGRATED RESTRAINT-PRESSURE SUIT SYSTEM Report, 7 Jun. 1965–28 Jun. 1966
R. S. Mazy, T. E. Mattingly, J. W. Felder, Jr., and C. F. Lombard Washington, NASA, Feb. 1967 49 p refs
(Contract NAS2-2868)
(NASA-CR-718; NSL-66-116) CFSTI: HC $3.00/MF $0.65 CSCL 06K

The fabrication of a working laboratory model of an internal restraint system for use in an integrated pressure suit system is presented. The system provides acceleration protection and thermal control by means of fluid-filled bladders. The thermal transport system is designed to remove at least 2,500 Btu/hr metabolic heat from the occupant. Results of studies conducted to determine the physical loads imposed on the restraint system under acceleration fields of ± 30 G_x; $+20$ G_z; -10 G_z and ± 15 G_y are included. Author

N67-18416* Battelle Memorial Inst., Columbus, Ohio.
DEVELOPMENT OF A MATHEMATICAL MODEL OF THE HUMAN OPERATOR'S DECISION-MAKING FUNCTIONS Final Report
J. T. Tou, R. E. Thomas, and R. J. Cress 31 Oct. 1966 233 p refs
(Contract NAS12-37)
(NASA-CR-80009) CFSTI: HC $3.00 CSCL 05H

Attempts are made to formulate a mathematical model describing the human operator's decision-making functions in a control system. The model simulates the evolution of control strategies selected by a human operator and the prediction of verbal heuristics used by such an operator. The proposed model consists of four modes of control: heuristic, gradient, terminal, and probing modes. The operator is assumed to be engaged in the on-line control of a dynamic system described by an ordinary linear differential equation subject to initial and final boundary conditions. The task consists of moving the system from the initial state to the terminal state and minimizing a quadratic performance criterion using information concerning state variables and cost variables which is obtained from meter readings available at discrete time during the control operation. The approach used was to allow 14 subjects to solve 23 first-order control problems (Mark I model) and allow 14 additional subjects to solve 12 second-order control problems (Mark II model). Results from the computer simulation and those from tests of subjects are analyzed. S.P.

N67-18542*# University of Southern Calif., Los Angeles. Dept. of Electrical Engineering.
THE ELECTRICAL CHARACTERISTICS OF SURFACE ELECTRODES FOR ELECTROCARDIOGRAPHY Final Report
Robert S. MacMillan, Robert N. Sato, Christopher Jacobs, and Richard J. DiMarco Dec. 1966 24 p refs
(Grant NGR-05-018-052)
(NASA-CR-82007; USCEE-184) CFSTI: HC $3.00/MF $0.65 CSCL 06B

The properties of surface electrodes, used for monitoring physiological processes of human subjects in the dynamic environment, were investigated. Application methods of the electrodes and the mechanisms of conduction are discussed. The electrical characteristics of electrodes were measured over a frequency range of 5 to 20,000 Hertz, and the electrode voltage ratios are tabulated over a range from 0 to 40 hours. Variations in skin preparation were found to affect the mean values of the electrode voltage ratios by as much as 5 dB. An equivalent circuit is shown, and it is believed that the circuit can be used to represent surface electrodes under a wide variety of conditions. N.E.N.

N67-18728*# Franklin Inst., Philadelphia, Pa. Systems Science Div.
MAN-COMPUTER ROLES IN SPACE NAVIGATION AND GUIDANCE, PHASE I
(Eugene Farber, Lloyd P. Crumley, and Lou Spiegel (GE) 18 Jan. 1967 114 p refs Revised
(Contract NAS12-128)
(NASA-CR-80011; TM-1-179R) CFSTI: HC $3.00/MF $0.65 CSCL 05H

The role of man in performing guidance and navigation while utilizing navigation systems of various degrees of complexity in future manned space flights was investigated. Selected mission constraints were used to calculate the required trajectories and guidance requirements. Navigational observations and measurements, and computations of obtained data were then combined in a first approximation to the required performance of a human operator. Analysis of the sensitivity data of the orbits and trajectories to guidance errors during the phase of the mission yielded the cost, and therefore, the relative importance of errors in different mission phases. A final determination and description of various types of automatic and manual navigation sensors formed there the basis for an aided-manual approach, and to a semiautomatic approach to space navigation and guidance man-machine requirements. G.G.

N67-19007*# Space/Defense Corp., Birmingham, Mich.
NO TITLE Technical Status Report, Nov. 4, 1966–Feb. 4, 1967
Donald L. Foster 17 Feb. 1967 9 p
(Contract NASw-870)
(NASA-CR-82467; TR67-104) CFSTI: HC $3.00/MF $0.65 CSCL 06B

Four single-cell units, and one multi-cell respirometer were fabricated for subsequent adaptation to space flight qualified hardware for the conduct of biorhythmicity studies using the potato tuber. The systems are the single-cell (SPUDNIK Mark I) and the multi-cell (SPUDNIK Mark II). Also described is a new technique for preparation of the potato specimens, resulting in improved capability for maintaining a viable specimen. To alleviate problems of mycotic growths, the newly plugged potato specimen was coated with parrafin, and inserted into the breadboard unit. After two months in the respirometer system, the new technique is considered promising. R.U.

N67-19092*# California Univ., Los Angeles. Space Biology Lab.
ELECTROENCEPHALOGRAPHIC BASELINES IN ASTRONAUT CANDIDATES ESTIMATED BY COMPUTATION AND PATTERN RECOGNITION TECHNIQUES
D. O. Walter, R. T. Kado, J. M. Rhodes, and and W. R. Adey [1966] 28 p refs Submitted for Publication
(Grant NsG-505)
(NASA-CR-82506) CFSTI: HC $3.00/MF $0.65 CSCL 06N

Methods used in acquisition and analysis of electrophysiological data from astronaut candidates are described. The data were analyzed to establish baselines covering a wide range of wakeful and sleep states. Physiological stimuli and perceptual and learning tasks were given to all subjects. Spectral analyses were performed by digital methods on scalp EEG channels. From the primary spectral density parameters, averages and variances were calculated for each scalp location. Despite wide individual differences between subjects, the group mean and/or pattern of variance in spectral densities for each test condition showed a characteristic pattern. The patterns were consistent with neurophysiological observations on organization of cortico-subcortical interrelations and cerebal systems. Recent evidence relating the scalp EEG to intracellular wave phenomena in cortical neurons is reviewed. Automated pattern recognition methods were applied to the primary outputs of spectral analysis. Results indicate an accuracy exceeding 90% in computed assignment of wakeful states, based on 10 to 20 second epochs of data from 4 EEG channels, and evaluation of 78 variables. Author

N67-19151*# Louisville Univ., Ky.
COMMUNICATION BY ELECTRICAL STIMULATION OF THE SKIN Semiannual Progress Report, May–31 Oct. 1966
Emerson Foulke 14 Jan. 1967 6 p refs
(Grant NGR-18-002-007)
(NASA-CR-82572) CFSTI: HC $3.00/MF $0.65 CSCL 06B

Progress is reported in a study to develop an electrocutaneous code for the communication of the English language at a useful rate. It was found that the best response alphabet consisted of the elements in the Katakana syllabary with native Japanese serving as the subjects. Emphasis was placed on modification of existing apparatus, determination of signal parameters, composition of the final code, and code learning. Among the conclusions are that locations used in composing the signals of the final code should be restricted to the fingertips, and that ac pulses should be used as stimuli. C.T.C.

06 CHEMISTRY

Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants.

N67-18211# Bureau of Mines, Minneapolis, Minn. Metallurgy Research Center.

HEAT CONTENT OF SOME BLAST-FURNACE AND SYNTHETIC SLAGS

Edward F. Foerster and P. L. Weston, Jr. 1967 27 p refs (BM-RI-6886)

A diphenyl ether calorimeter was used to determine the heat contents of natural and synthetic blast-furnace slags. For solid slags, enthalpy (H_T-H_{298}) at 1,448° to 1,680°K ranged from 282.1 to 348.5 cal/g (±3%); liquid slag values were 400.1 to 514 cal/g (±3%) in the temperature range between 1,626° and 1,890°K. Experimental results for liquid slags were 14.3 to 16.2% higher than the enthalpies calculated from thermodynamic tables; values for solid slags ranged from 5.3% lower to 3.9% higher than calculated values. Experimental results for liquid synthetic slags ranged from 14.9 to 24.3% higher than the calculated enthalpies; values for solid synthetic slags were from 1.0 to 3.4% higher. Author

N67-18282# Pratt and Whitney Aircraft, East Hartford, Conn.

DESULFURIZATION OF LIQUID HYDROCARBON FUEL FOR FUEL CELLS Interim Technical Progress Report, 10 Jan.–10 Jul. 1966

Herbert Setzer and Arthur Kaufman 30 Jul. 1966 63 p refs (Contract DA-44-009-AMC-1446(T))

(PWA-2885; AD-643183) CFSTI: HC $3.00/MF $0.65

It was the purpose of this contract to investigate the feasibility of using, and to select a method for utilizing, sulfur-bearing fuels of the JP-4, CITE or Diesel type in fuel cell powerplants by desulfurization of the fuel. System studies were made and catalytic guard chamber materials evaluated experimentally to select a desulfurization technique and guard chamber catalyst-absorbent material. These investigations show that using the optimum desulfurization process with a 100-hour replaceable cartridge results in approximately a 3% weight increase in the indirect hydrocarbon-air fuel cell system if JP-4 with 400 ppm sulfur is used rather than a sulfur-free hydrocarbon fuel. Two catalysts (both of which are high nickel content, hydrogenation catalysts) were found to perform very effectively as catalyst-absorbent materials for desulfurization in the presence of steam reformer reactants. Finally, a demonstration test with JP-4 containing 470 ppm sulfur was run using an existing hydrogen generator modified for operation with a desulfurization cartridge and utilizing recycled dilute hydrogen. Author (TAB)

N67-18283# Olin Mathieson Chemical Corp., New Haven, Conn. Chemicals Group.

THE DIPOLE MOMENTS OF BORON AND CARBON BROMINATED CARBORANES

R. Maruca, H. Schroeder and A. W. Laubengayer Dec. 1966 11 p refs Submitted for Publication

(Contract Nonr-3395(00))

(TR-34; AD-643010) CFSTI: HC $3.00/MF $0.65

In agreement with theoretical considerations and earlier experimental evidence, dipole moment measurements of selectively substituted o- and m-carborane derivatives established that in the polar icosahedra of o-B10H10C2H2 and m-B10H10C2H2 the carbon atoms and the borons adjacent to them constitute the positive pole. Author (TAB)

N67-18290# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

UTILIZING WASTES OF THE SYNTHETIC RUBBER INDUSTRY IN THE ROLE OF ACID CORROSION DECELERATORS

V. A. Khitrov, V. P. Zadorozhniy et al 30 Mar. 1966 12 p refs Transl. into ENGLISH from Khim. Prom. (Leningrad), no. 4, 1964 p 307–310

(FTD-TT-65-1626; TT-66-62519; AD-641108) CFSTI: HC $3.00/MF $0.65

When manufacturing divinyl by catalytic decomposition of ethyl alcohol, synthetic rubber plants are using various wastes of complex composition, which can serve as decelerators of acid corrosion of certain metals. To these wastes belong so called 'foamy reagent' (an alcohol–hydrocarbon mixture), vat remains (low B.P. hydrocarbons), and motor fuel (non-polymerized hydrocarbons). The effectiveness of these wastes in retarding corrosion in the following systems is reported: low carbon steel 08 in 1 and 7 percent solutions of sulfuric and hydrochloric acid solutions; stainless steel 1KH18N9T in 1 and 7 percent of hydrochloric acid; copper in 3 percent nitric acid. TAB

N67-18292# Olin Mathieson Chemical Corp., New Haven, Conn. Chemicals Group.

VAPOR PHASE ISOMERIZATION OF A O-CARBORAN

S. Papetti, C. Obenland, and T. L. Heying Dec. 1966 17 p refs

(Contract Nonr-3395(00))

(TR-33; AD-643009) CFSTI: HC $3.00/MF $0.65

An improved process for the conversion of ortho carborane to its meta and para isomers involves heating carborane vapors, admixed with an inert carrier gas in a heated tube at atmospheric pressure. This process accomplishes the isomerization rapidly in a continuous fashion, eliminating the need for the heavy pressure equipment required in previous methods. Optimum conversion of ortho to meta carborane occurred at a tube temperature of 600C, with a residence time of 0.30 to 0.48 minutes and mass flows of 0.73 to 2.98 grams/minute; the meta isomer was recovered in yields of 88 to 95%. Mixtures of meta and para isomers were formed at 700C, the yield of para isomer being about 22% under optimum conditions. Author (TAB)

N67-18295# Illinois Univ., Urbana. Dept. of Chemistry and Chemical Engineering.

NUCLEAR MAGNETIC RELAXATION STUDIES OF $(CD_3O)_2{}^{11}BH$

N. Boden, H. S. Gutowsky, J. R. Hansen, and T. C. Farrar 8 Nov. 1966 9 p refs Submitted for Publication

(Contract N00014-66-C0010-A04)

(TR-1; AD-643333) CFSTI: HC $3.00/MF $0.65

The relaxation of quadrupolar nuclei in liquids lends itself in favorable cases to the approximate determination of quadrupole coupling constants which are not readily accessible by other means. A report is given of such an estimate of the 11B quadrupole coupling constant ((e sq.)qQ sub 11B)/h in dimethoxy (d6) borane (11B), (CD3O)2BH. The result is 2.6 MHz. Also, an activation energy of 1.2 plus or minus 0.1 kcal/mole was found for molecular reorientations in the liquid and a temperature-independent magnitude of 162.0 plus or minus 1.0 Hz was determined for the scalar internuclear coupling constant J sub 11BH. Author (TAB)

N67-18328*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

POLYMERIZATION OF ACID CHLORIDES WITH EPOXIDES

H. Marsh, Jr. and J. Hutchison *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 106–109 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

The study shows that the acid chloride–epoxide polymerization is not useful for a model system because of the difficulty in

controlling side reactions leading to cross-linking. However, the system shows promise for synthesis, especially where cross-linking is desired in the product. The system's apparent high temperature stability is of interest for propellant binders, particularly with regard to heat sterilization. R.N.A.

N67-18329*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
F^{19} NMR OF NITROSO RUBBERS
J. D. Ingham and D. D. Lawson *In its* Space Programs Sum. No. 37-42, Vol. IV 31 Dec. 1966 p 110-113 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

A nuclear magnetic resonance study was conducted to determine the structure of nitroso rubber with respect to the nitrogen-oxygen orientation of trifluoronitrosomethane units. Previous F^{19} nuclear magnetic resonance spectra indicated a regular orientation, however, the spectra were observed at lower resolution than those in this study. R.N.A.

N67-18330*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
REACTIONS OF N-VINYLCARBAZOLE WITH ANIONIC INITIATORS
A. Rembaum, A. M. Hermann, and R. Haack *In its* Space Programs Sum. No. 37-42, Vol. IV 31 Dec. 1966 p 113-119 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

Results are presented of the reaction of N-vinylcarbazole with anionic initiators such as metallic sodium, "living polystyrene", and butyllithium. It is demonstrated that the radical anion of N-vinylcarbazole is easily formed at relatively low temperature, it does not undergo dimerization, it does not polymerize but initiates the polymerization of other monomers under well specified conditions, and it is unstable at room temperature because of a C-N bond scission. The failure of this monomer to polymerize by means of anionic initiators can be explained by the high concentration of negative charges around the vinyl group. Author

N67-18381# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.
DIVISION ANALYTICAL BRANCH FOR 1965 Annual Report
Ralph C. Shank Jun. 1966 256 p refs
(Contract AT(10-1)-205)
(IDO-14679)

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N67-18382# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.
ANALYTICAL DEVELOPMENT. WET CHEMISTRY METHODS
In its Div. Anal. Branch for 1965 Jun. 1966 p 7-23 refs (See N67-18381 08-06)

Summary reports are given of the application of wet chemistry methods to the following: determinations of acidity in zirconium fuel process samples, of microgram amounts of boron, and of small amounts of carbon in metals; microdistillation-colorimetric fluoride determination; separation of lithium for mass isotopic analysis; determination of mercury in sagebrush and by spectrophotometric dithizone methods; separation of plutonium for mass spectroscopic analysis; determination of uranium; evaluation of titrimetric ethylenediaminetetraacetic acid (EDTA) methods of analysis with visual indicator and points; and use of citrate-EDTA masking for the selective determination of iron with 1,10-phenanthroline. A table is included giving recommended visual EDTA titration methods. L.E.W.

N67-18383# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.
RADIOCHEMICAL METHODS
In its Div. Anal. Branch for 1965 Jun. 1966 p 24-30 refs (See N67-18381 08-06)

Radiochemical methods are briefly considered, and reviews are given of their application to determinations of Am^{241} in CPP final product samples of Ce^{143} in the presence of large amounts of Np^{239} and to separations of Lu^{172} and Tm^{172} from adjacent lanthanides, of short-lived neutron-deficient isotopes, and of the lanthanide group from irradiated plutonium. A summary of the separation procedures for short-lived neutron-deficient isotopes formed by cyclotron irradiations is presented in tabular form. Recommendations were made for improving the reliability of results obtained when using gravimetric yield determinations for radiochemical analytical methods. Preparation and standardization of carrier solutions and stoichiometry of the precipitate were emphasized. L.E.W.

N67-18384# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.
ELECTROANALYTICAL STUDIES
In its Div. Anal. Branch for 1965 Jun. 1966 p 30-33 refs (See N67-18381 08-06)

Research to develop a fundamental understanding of the electrochemistry of various species based on mathematical analysis of electrode responses is summarized. These methods have been applied to the interpretation of step-functional controlled-potential measurements of second-order homogeneous reactions. The derivation of mathematical relationships to correct electrode response data for various changes of current is also mentioned. Summary details are given on investigations of the uranium (V) disproportionation reaction in perchloric acid and of the coulometric

determination of uranium to ascertain the effect of diverse ions. Developments in instrument design reported include: a digital timer and waveform generator for flexible control of input signal waveforms and output signals, a simplified transfer analysis for rapid evaluation of the performance of the operational amplifier instrumentation in controlled-potential electrolysis experiments, and modification of the electroanalytical potentiostat. L.E.W.

N67-18385# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.
DEVELOPMENT IN SUPPORT OF LOFT PROGRAM
In its Div. Anal. Branch for 1965 Jun. 1966 p 34–41 ref (See N67-18381 08-06)

An evaluation of the gas particulate sampler for the loss of fluid test (LOFT) program is reported. Experiments to verify the predicted sorption properties of various components of the cartridge for I species and for Kr–Xe under LOFT-simulated conditions are described. The results of temperature stability tests are summarized in tabular form, as well as results of tests made in He and in steam air atmospheres to determine I vapor retention of those filters that were thermally stable. Boron nitride was studied as a specific sorbing medium for Kr, Xe, and I. Results indicated that neither Kr nor Xe were sorbed to any significant extent by boron nitride; however, I sorption in excess of 97% was measured in three different atmospheres. Methods of determining fission products in LOFT samples are reported including the separation of Te and I from other fission products and sequential, fractional separation of multiple fission products from plateout samples and decontamination media. Finally, methods of dissolution of LOFT fuel are discussed, and dissolution methods of fused UO_2–ZrO_2–Zircaloy-4 cermet are presented in tabular form. L.E.W.

N67-18386# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.
REMOTELY OPERATED FACILITIES
In its Div. Anal. Branch for 1965 Jun. 1966 p 42 ref (See N67-18381 08-06)

Summary reports are given of development and improvement of several analytical facilities, including the Cell X cave, the CPP additional alpha handling facility, and the Remote Analytical Facility (RAF) hot cell. Remotely operated equipment in Cell X cave was equipped with shield assemblies to cut down radioactive background. The status and purpose of the facilities are briefly outlined. L.E.W.

N67-18388# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.
SPECTROSCOPY. SPECTROCHEMICAL ANALYSIS
In its Div. Anal. Branch for 1965 Jun. 1966 p 47 refs (See N67-18381 08-06)

The determination of iridium in aluminum, the determination of boron in thorium, and the separation and determination of Sm^{151} in CPP feed solutions by spectrochemical analysis are briefly reported. Iridium in aluminum was studied to determine whether direct excitation was preferable to dissolution; the results indicated a coefficient of variation of 3.5% with a correction for bias of the matrix. The spectrochemical study of boron in thorium indicated that there was residual thorium interference even when second-order dispersion was used. Three different concentrations of thorium were used to compensate for the interference, and the coefficient of variation for five samples was 4.5%. The process streams flowing into the CPP waste tanks were analyzed for 90-yr Sm^{151} to determine the amount present and evaluate a separation process. L.E.W.

N67-18390# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.
CHEMICAL ANALYSIS. MANPOWER EQUIPMENTS FOR DIFFERENT ANALYSES
In its Div. Anal. Branch for 1965 Jun. 1966 p 51–53 (See N67-18381 08-06)

A table is presented which shows the manpower requirements for some of the general methods of chemical analysis. The time per analysis was obtained from total analysis and total hours accumulated from daily time records. It is pointed out that the time per analysis applies only if three or more samples are analyzed for the same constituent at the same time. L.E.W.

N67-18391# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.
ANALYTICAL SERVICES
In its Div. Anal. Branch for 1965 Jun. 1966 p 53–54 (See N67-18381 08-06)

The colorimetric determination of selenium on polystyrene filters is mentioned, and the dissolution of ternary fuels (i.e., calcium, uranium, and zirconium oxides) is briefly reported. A mixed acid solution was used on two 4 g samples and complete dissolution was accomplished. Summary details are also given on the analysis of irradiated thorium samples, in which the samples were dissolved and analyzed for aluminum, thorium, uranium, and Cs^{137}, and on the determination of copper and aluminum in copper–aluminum alloys by chelometric analysis with EDTA after sample dissolution in a nitric–hydrochloric acid medium. L.E.W.

N67-18392# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.
IMPROVEMENTS IN METHODS AND EQUIPMENT
In its Div. Anal. Branch for 1965 Jun. (See N67-18381 08-06)

Summary reports of work done in the following topics are given: (1) colorimetric determination of iodine from aqueous samples containing iodide, (2) correction of interference of stainless steel components for radiochemical strontium determination, (3) method for measuring Xe-133m and Xe-135 without waiting for decay of the Xe-135, (4) determination of iodine loss in polypropylene dissolvers, (5) modification of the Kjeldahl procedure for nitrate and ammonia, (6) high activity gamma spectrometry, (7) purification of mercury, (8) improvements in the waste disposal system at the Remote Analytical Facility (RAF), and (9) design of bellows for the RAF manipulators. L.E.W.

N67-18394# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.
QUALITY CONTROL
J. E. Rein and G. J. Curtis *In its* Div. Anal. Branch for 1965 Jun. 1966 p 63–69 refs (See N67-18381 08-06)

Continuation of a comprehensive quality control program is reported, including summary details on bias and precision data, training and testing programs, standards and reagents, and variables of liquid storage stability. A summary of the precision data for routine methods for 1965 is presented in tabular form, and a test used in connection with chemist training is included. Finally, results of an investigation of the effect of several variables on the storage stability of liquids are presented in tabular form, including information on containers, stoppers, aqueous media, and organic media. L.E.W.

N67-18396# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.
METHODS ADDED TO ANALYTICAL MANUAL IN 1965, APPENDIX B
In its Div. Anal. Branch for 1965 Jun. 1966 p 75–191 refs (See N67-18381 08-06)

Thirteen analytical methods are outlined, including abstract, applicability, discussion, safety precautions, special apparatus and

reagents, procedure, calculations, and references. The procedures covered include: titrimetric determination of acidity of hydrolyzable ion solutions, microdistillation—colorimetric fluoride determination, extraction—fluorophotometric determination of uranium, determination of milligram amounts of uranium by an extraction—spectrophotometric measurement method, colorimetric determination of selenium, titrimetric determination of thorium (and aluminum) in thorium metal and thorium metal slug clad with aluminum, colorimetric determination of iodine, and ammonia, nitrate and ammonia, spectrophotometric determination of inorganic nitrate and m ammonia, spectrophotometric determination of milligram levels of phosphorus as molybdivanadophospheric acid, volumetric determination of chromium (VI), titrimetric determination of peroxide, colorimetric determination of iron with 1,10-phenanthroline, and determination of total carbon. L.E.W.

N67-18396# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.

METHODS ADDED TO ANALYTICAL RADIOCHEMICAL MANUAL IN 1965, APPENDIX C

In its Div. Anal. Branch for 1965 Jun. 1966 p 193–229 refs (See N67-18381 08-06)

Several radiochemical analytical procedures are described, including methods for the determinations of Am-241 and CPP final product, of Ce-143 in samples containing Np-239, and of Np-237 in high concentration U-235 samples; absolute beta counting of low activity liquid-waste samples; determination of gross beta activity; and dissolution and separation of various fission products that are released and collected on plateout coupons and other samples during the meltdown of ≈10-day cooled nuclear fuel. Information given for each method includes abstract, applicability, discussion, safety precautions, apparatus and reagents, procedure, calculations, and references. L.E.W.

N67-18404*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

PREPARATION AND INVESTIGATION OF ABSORBING MAGNETOMETER CELLS WITH DOUBLE RADIOOPTICAL RESONANCE

Yu. I. Borisova, E. I. Dashevskaya, and A. N. Kozlov 14 Dec. 1966 5 p refs Transl. into ENGLISH from Novinki Geofizicheskogo Pribiristrovenia Magnitometriva (USSR), v. 23, 1965 p 16–19

(Contract NAS5-12487)

(NASA-CR-81874; ST-INST-10-546) CFSTI: HC $3.00/MF $0.65 CSCL 07D

Magnetometers utilizing the double radiooptical resonance phenomenon in vapors of alcaline metals and in metastable helium have been lately the object of greater and greater use as highly-sensitive and absolute devices, of which the absorbing cell is the principal part. The present note describes the method worked out in the magnetic laboratory of IZMIRAN for their filling and covering for potassium, rubidium and caesium absorption chambers. Author

N67-18418* Globe-Union Inc., Milwaukee, Wis.

A PROGRAM TO DEVELOP A HIGH-ENERGY DENSITY PRIMARY BATTERY WITH A MINIMUM OF 200 WATT HOURS PER POUND OF TOTAL BATTERY WEIGHT Quarterly Report, Jul. 1–Sep. 30, 1966

William E. Elliott, James R. Huff, Judith L. Jamrozy, Guy D. McDonald, Gerald L. Simmons et al 15 Oct. 1966 99 p

(Contract NAS3-6015)

(NASA-CR-72158; QR-9) CFSTI: HC $3.00 CSCL 10C

Test runs with a cupric fluoride cathode in the alkali metal hexafluorophosphates, in N-nitrosodimethylamine, in $LiClO_4$-propylene carbonate, and in phenyltrimethylammonium hexafluorophosphate-NDA demonstrated film formation on the cathode's surface. Half-cell screening tests with silver oxide and silver oxynitrate cathodes in $LiPF_6$-NDA, $LiClO_4$-dimethylsulfoxide (DMSO), $LiPF_6$-DMSO, and $LiAlCl_4$-PC were carried out, and lithium anode behavior in the electrolytes used was investigated. An electrode of lithium laminated on a copper sheet was found feasible for use. Also reported were several compatibility studies for Mg and AgO in $AlCl_3$-acetonitrile, and AgO in $LiPF_6$-NDA. A Bio-Rex C-60 hydrogen form ion-exchange membrane was found to have excessive resistance when used as a separator. G.G.

N67-18443*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

ANALYSIS OF FLUORESCENCE SPECTRA OF RARE EARTH CHELATES. I: INTERNAL STARK SPLITTING IN EUROPIUM DIBENZOYLMETHIDE

Sven Bjorklund, N. Filipescu (George Washington Univ.), N. Mc Avoy, and J. Degnan [1965] 23 p refs Submitted for Publication

(NASA-TM-X-57104) CFSTI: HC $3.00 CSCL 07C

The emission spectrum of Eu tetrakis (dibenzyolymethide) piperidinium in crystalline powder at 77°K was analyzed in detail employing first-order perturbation theory. The complete equivalence between a crystalline field and a molecular (ligand) field in chelates with respect to the Stark splitting of the intra-4f levels was demonstrated. The existence of two stereoisomers was established and found consistent with a dodecahedral and an antiprismatic configuration. The most likely assignment for the fluorescence lines was found for each of the two isomers. The ligand field parameters for the equivalent point charge models of the two stereoisomers was determined. The conclusions about the shape of the two molecular species drawn from these parameters are consistent with the configuration of dodecahedron and distorted antiprism respectively. A satisfactory agreement was found between experiment and theory. Author

N67-18468# Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics.

ESR OF THE EXCITED ^2E LEVEL OF Cr^{3+} AND V^{2+} IN MgO

Lloyd L. Chase Sep. 1966 13 p refs Presented at the Conf. on Opt. Properties of Ions in Solids, Baltimore

(Contract AT(30-1)-2150)

(NYO-2150-18; CONF-660929-1) CFSTI: HC $3.00/MF $0.65

The magnetic resonance of the ^2E level of Cr^{3+} and V^{2+} has been investigated in the cubic field of MgO. Interactions with higher-lying levels of the d^3 configuration lead to a magnetic splitting of the orbital states of ^2E which appears in the observed resonances as an absorption band having a width at 24 Gc ranging from 12 to 800 gauss as a function of magnetic field orientation. This result is explained on the basis of initial splitting of 2E by random strain. A hyperfine spectrum is observed for V^{2+} for which the hyperfine constant is in reasonable agreement with the expected orbital hyperfine contribution. Author (NSA)

N67-18472# European Atomic Energy Community, Ispra (Italy). Chemistry Dept.

ANALYTICAL STUDIES ON SAP [ETUDES ANALYTIQUES SUR LE SAP]

J. L. Collin and G. Serrini Brussels, EURATOM, Jul. 1966 70 p refs In FRENCH; ENGLISH summary

(EUR-3064.f)

Various analytical determinations for powders and sintered products of SAP are reported. The following compounds and elements were analyzed: aluminum, aluminum oxide, total and free carbon, carbonate, fats, aluminum carbide, combined nitrogen, hydrogen, water, iron, silicon, zinc, and nickel. The analytical results of aluminum oxide, total carbon, iron, silicon, and zinc were compared with the findings obtained by other laboratories doing light metal analysis. Author (NSA)

N67-18519*# Vanderbilt Univ., Nashville, Tenn. Dept. of Chemistry.

THE STATUS OF ULTRACHEMICAL ANALYSIS FOR SEMICONDUCTORS Final Report

Robert V. Dilts and Larry C. Hall 15 Dec. 1966 215 p refs

(Contract NAS8-20196)

(NASA-CR-82011) CFSTI: HC $3.00/MF $0.65 CSCL 07D

A literature review on the state-of-the-art of ultratrace chemical analysis of materials of interest to the field of semiconductors is presented, and details are given on atomic absorption spectroscopy, emission spectroscopy, and neutron activation methods. The general theory for each method is described, and recent developments, instrumentation, materials and sources used, and applications are discussed. Typical results are tabulated, recommendations are indicated, and extensive bibliographies are included. Among the conclusions are: (1) Atomic absorption spectroscopy is accurate, sensitive, and eminently suitable for semiconductor material analysis. (2) Emission spectroscopy is an excellent technique and permits the rapid direct analysis of solid samples. (3) Activation analysis the most general, sensitive method for elemental detection and is expected to be more flexible, sensitive, and faster in the near future. N.E.N.

N67-18549*# Stanford Research Inst., Menlo Park, Calif.

EFFECT OF ENVIRONMENT ON THERMAL CONTROL COATINGS

S. R. Morrison, T. Freund, and N. Endow 15 Dec. 1966 40 p refs Prepared for JPL

(Contracts NAS7-100; JPL-951522)

(NASA-CR-82100; TPR-3) CFSTI: HC $3.00/MF $0.65 CSCL 07D

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2. ANALYSIS OF SEMICONDUCTOR–ELECTROLYTE CAPACITY p 21–32 (See N67-18451 08-06)

N67-18550*# Stanford Research Inst., Menlo Park, Calif.

MECHANISM OF CATHODIC PROCESSES ON THE SEMICONDUCTOR ZINC OXIDE

T. Freund and S. Roy Morrison *In its* Effect of Environment on Thermal Control Coatings 15 Dec. 1966 p 1–20 (See N67-18549 08-06) CFSTI: HC $3.00/MF $0.65

The cathodic reduction of the aqueous ferricyanide ion was investigated on a single crystal zinc oxide electrode. It is concluded that the rate determining step of the reduction process is the capture of electrons from the conduction band of the ZnO by the sorbed ferricyanide ions. This process was shown to be irreversible, i.e., electrons are not transferred from sorbed ferrocyanide to the semiconductor electrode. The capacitance, voltage and current were measured as a function of the concentration. The rate of ferricyanide reduction was measured by the current and was found to be first order in sorbed ferricyanide ion and first order in the electron concentration at the surface. The electron concentration at the surface of the electrode was determined from the capacitance-voltage measurement. The sorption isotherm for ferricyanide was found to be linear in concentration over the range from 7×10^{-5} to 0.7 Molar. Author

N67-18551*# Stanford Research Inst., Menlo Park, Calif.

ANALYSIS OF SEMICONDUCTOR—ELECTROLYTE CAPACITY

In its Effect of Environment on Thermal Control Coatings 15 Dec. 1966 p 21–32 (See N67-18549 08-06) CFSTI: HC $3.00/MF $0.65

The distribution of voltage and stored charge for the electrolyte–semiconductor interface is examined to be clear about the origin of the capacity measured, and to distinguish space charge capacity, surface state capacity, and other possible contributions to the measured capacity. The approximation, that the measured capacity equals the space charge capacity, is considered to be justified, and it may be assumed for most semiconductor–electrolyte systems, as long as the current drawn from the system is low enough that adsorption equilibrium is maintained. N.E.N.

N67-18644# United Kingdom Atomic Energy Authority, Harwell (England).

EVALUATION OF ISOTOPE ANALYTICAL RESULTS FOR ESTIMATION OF THE METHOD OF WORKING AND QUALITY OF AN ELECTROMAGNETIC ISOTOPE SEPARATOR

F. Timpl Feb. 1966 17 p refs Transl. into ENGLISH from Abhandl. Deut. Akad. Wiss. Berlin, Chem., Geol., Biol. (Berlin), no. 7, 1964 p 291–299

(NP-TR-1423)

By means of suitable normalization and levelling of the results obtained from mass spectrometric isotope analysis of materials collected during a separation run with electromagnetic isotope separators, a representation of the distribution of the beam over the collector pockets is obtained which is remarkably informative. It is possible to obtain indications not only of those reasons for the occurrence of isotopic contaminations which are imposed by the machine, and hence of the possible improvement of the machine, but also of the reasons for such contaminations which are imposed by the mode of operation. Simultaneously, from this analysis of the outer pockets the local distribution of the beams over all the pockets can be deduced. From this, a relatively reliable conclusion can be drawn as to the enrichment factor and also the isotopic composition of the other pocket materials, without it being necessary to analyze them mass spectrometrically. This is not only advantageous from the point of view of saving work, but is also of economic importance, particularly in the case of rare isotopes and costly charge materials. Author (NSA)

N67-18645# United Kingdom Atomic Energy Authority, Harwell (England).

OPTIMISATION OF THE WORKING PARAMETERS FOR ELECTROMAGNETIC ISOTOPE SEPARATORS

F. Timpl, R. H. Winkler et al Feb. 1966 12 p refs Transl. into ENGLISH from Abhandl. Deut. Akad. Wiss. Berlin, Kl. Chem. Geol. Biol. (Berlin), no. 7, 1964 p 285–290

(NP-TR-1422)

In an electromagnetic isotope separator, the individual parameters that determine the machine's performance interact with each other. The purpose of optimizing the machine is to determine those working values at which the significant characteristic quantities, such as the enrichment factor and the amount of material collected per unit time, reach their optimum values. In order to do this, the performance of the machine was studied as a function of different working parameters. It was found that there are several correlated pairs of values, for example, the source-oven and cathode heating, at which relative maxima of the collector current are obtained. However, an absolute maximum is obtained only with a quite specific group of values of the different parameters. It is this group of working values alone which can be regarded as the optimum of an economical separator operation. NSA

N67-18648*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

NEWLY IDENTIFIED RESONANCE LINES OF Ni XIX, Cu XX, AND Zn XXI

U. Feldman, C. Cohen, and M. Swartz Oct. 1966 9 p refs

(NASA-TM-X-55684; X-614-66-496) CFSTI: HC $3.00/MF $0.65 CSCL 07D

Using a grazing incidence spectrometer and a low inductance condensed spark source, the authors have observed spectra of Ni xix, Cu xx and Zn xxi. By extrapolating the known data of the Ne i isoelectronic sequence, the new lines have been identified as belonging to transition arrays between the ground level $2s^22p^6\ ^1S_0$ and the following electronic configurations: $2s^22p^53s$, $2s^22p^53d$, and $2s2p^63p$. Some of these lines may be emitted from the solar corona. Author

N67-18707* National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
THE ELECTRON MICROPROBE FOR CHEMICAL ANALYSIS
John J. Park [1965] 14 p refs Submitted for publication
(NASA-TM-X-57083) CFSTI: $3.00 CSCL 07D

The electron microprobe is used for the qualitative and quantitative analysis of areas of micron-size diameter. By means of a finely focused electron beam, the X-ray fluorescence analysis of selected areas are obtained for elements below magnesium in the periodic table. The correction procedures necessary for application to the raw data is discussed, and results obtained by the detection of back-scattered electrons and by characteristic X-ray emission are presented. Examples of analyses to detect homogeneous or inhomogeneous mixtures, the distribution of phases within a matrix, and the diffusion of elements are also included. Author

N67-18752*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
NEWLY IDENTIFIED LINES OF Ni XVIII, Cu XIX, and Zn XX IN THE SODIUM I ISOELECTRONIC SEQUENCES
Uri Feldman, Leonard Cohen, and Marvin Swartz Nov. 1966 8 p ref
(NASA-TM-X-55693; X-614-66-538) CFSTI: HC $3.00/MF $0.65 CSCL 07D

Lines are reported belonging to Ni xviii, Cu xix, and Zn xx for the following transitions: $3s^2S-4p^2P^o$, $3p^2P^o-4s^2S$, $3p^2P^o-n_1d^2D$ ($n_1=4,5$) and $3d^2D-n_2f^2F^o$ ($n_2=r,5,6$). Wavelengths, energies and term values are given. Author

N67-18773# Mallinckrodt Chemical Works, Weldon Spring, Mo. Uranium Div.
A SPECTROCHEMICAL METHOD FOR THE DETERMINATION OF INDIVIDUAL RARE EARTH ELEMENTS IN URANIUM ORE CONCENTRATES AND HIGH-PURITY URANIUM COMPOUNDS
R. S. Vogel, T. F. Dubowski, J. R. Nelms, and A. L. Sheller 19 Jan. 1966 18 p refs
(Contract W-14-108-ENG-8)
(MCW-1498) CFSTI: HC $3.00/MF $0.65

A method is described for the determination of specific rare earth elements in uranium ore concentrates and high-purity uranium compounds. The method involves a preliminary chemical concentration of the rare earth elements, followed by a spectrographic analysis of the rare earth concentrate by direct-current excitation, using neodymium as an internal standard. In the preliminary chemical concentration, uranium is removed by extraction with tri-*n*-butyl phosphate (TBP). The rare earths as well as other insoluble hydroxides are then precipitated by ammonium hydroxide. Residual uranium is removed by a second ammonium hydroxide precipitation in the presence of ethylenediamine tetraacetic acid which forms a soluble rare earth complex. The rare earths are then precipitated as oxalates and ignited to oxides. The rare earth concentrate is then analyzed spectrographically by direct-current arc excitation and densitometric methods. The calibrated analytical range for a given element is 1 part-per-billion to 100 parts-per-million on a sample basis. The average precision of a single determination is 22% (relative) at the 95% confidence level. Author

N67-18774# California Univ., Livermore. Lawrence Radiation Lab.
PREPARATION OF MARCO-AMOUNTS OF PURE AMERICIUM METAL
W. Z. Wade and T. Wolf 2 Aug. 1966 27 p refs
(Contract W-7405-ENG-48)
(UCRL-14513) CFSTI: HC $3.00/MF $0.65

Knowledge of the physical and chemical properties of americium has come mostly from measurements made on very small quantities of this element—micrograms or milligrams. Much better determinations of americium's properties were desired, and to obtain them it became necessary to produce relatively large quantities of americium metal of exceptionally high purity. This report describes the process technology developed to produce ultrapure Am^{241} metals in the quantities needed. A total of 166.7 g of Am^{241} was processed in 13 separate reduction runs. Purity ran as high as 99.99%, and yield efficiency as high as 93%. Author

N67-18897# California Univ., Livermore. Lawrence Radiation Lab.
AUTOMATION IN ANALYTICAL CHEMISTRY
Jack W. Frazer and Roger E. Anderson 16 Jun. 1966 11 p refs
(Contract W-7405-ENG-48)
(UCRL-14957) CFSTI: HC $3.00/MF $0.65

The reasons for automation of an analytical chemistry laboratory and the progress to date on using a control computer in analytical procedures are discussed. The analytical techniques considered are gas chromatography; mass spectrometry; simultaneous carbon, hydrogen, and nitrogen analyses; surface-area determinations; vacuum-fusion analyses; and various other gas-transfer determinations. Author (NSA)

N67-18927*# National Aeronautics and Space Administration, Washington, D. C.
HIGH-TEMPERATURE OXIDATION OF SILICIDES OF SOME RARE-EARTH METALS. [VYSOKOTEMPERATURNOYE OKISLENIYE SILITSIDOV NEKOTORYKH REDKOZEMEL'NYKH METALLOV]
T. S. Verkhoglyadova and L. A. Dvorina Jan. 1967 9 p refs Transl. into ENGLISH from Zh. Fiz. Khim. (Moscow), v. 40, no. 9, 1966 p 2250–2254
(NASA-TT-F-10663) CFSTI: HC $3.00/MF $0.65 CSCL 07B

The relative stability of silicides of some rare-earth metals in air at high temperatures is investigated. It is found that scandium silicide is the most stable, and yttrium silicides are least stable. Author

N67-18978*# Stanford Research Inst., Menlo Park, Calif.
SYNTHESIS OF ATACTIC AND STEREOREGULAR VINYLAROMATIC POLYMERS AND A STUDY OF THEIR REACTIONS WITH ALKALI METALS Final Report
Jorge Heller and Donald B. Miller 15 Dec. 1966 63 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951326; SRI Proj. FRD-5775)
(NASA-CR-82397) CFSTI: HC $3.00/MF $0.65 CSCL 07C

Details are given on the synthesis and characterization of narrow molecular weight distribution polymers from 1-vinylnaphthalene, 2-vinylnaphthalene, and 4-vinylbiphenyl; the synthesis and characterization of stereoregular polymers from 1-vinylnaphthalene, 2-vinylnaphthalene, 4-vinylbiphenyl, and 9-vinylcarbazole; and the reaction of these vinylaromatic polymers with alkali metal atoms. L.E.W.

N67-19018# Los Alamos Scientific Lab., N. Mex.
THE TITRIMETRIC DETERMINATION OF COPPER IN COPPER–BORON CARBIDE MIXTURES

Alvin D. Hues and William H. Ashley 12 Oct. 1966 10 p refs
(Contract W-7405-ENG-36)
(LA-3552) CFSTI: HC$3.00/MF$0.65

A titrimetric method was modified and applied to the determination of copper in copper–boron carbide mixtures. The copper in the sample is dissolved with nitric acid and the resulting solution buffered with ammonium acetate. The copper is titrated potentiometrically, in the presence of the undissolved boron carbide, with a 0.05 M solution of EDTA, using a platinum-tungsten electrode system. The copper found in 30 simulated samples, prepared to contain known amounts of boron carbide and copper over the range of 50 to 100% copper, average 99.98% of the amount added, with a relative standard deviation of 0.04% for a single determination. The time required for an analysis is less than one-half that required by the conventional electrolytic method.
Author (NSA)

N67-19061# Battelle Memorial Inst., Columbus, Ohio.
CHEMICAL-EQUILIBRIUM STUDIES OF ORGANIC-IODIDE FORMATION UNDER NUCLEAR-REACTOR-ACCIDENT CONDITIONS
Russell H. Barnes, John F. Kircher, and Charles W. Townley 15 Aug. 1966 34 p refs
(Contract W-7405-ENG-92)
(BMI-1781) CFSTI: HC$3.00/MF$0.65

The presence of CH_3I in nuclear-reactor environments poses a potential hazard because of the difficulties involved in removing this compound from gases using conventional trapping techniques. To gain insight into the the chemical processes leading to CH_3I formation, a study was performed to calculated equilibrium concentrations of CH_3I and other important species for a range of conditions typical of reactor-accident systems. The results of this study indicated that chemical systems containing simple compounds such as CO_2, H_2O, CH_4, and iodine would be expected to generate CH_3I. The calculated equilibrium concentrations of CH_3I were found to be several orders of magnitude lower than those observed in comparable experimental systems, indicating that chemical-kinetic factors are important. A preliminary study of the practicality of solving the kinetic problem was made.
Author (NSA)

N67-19064# Los Alamos Scientific Lab., N. Mex.
THE X-RAY FLUORESCENCE SPECTROMETRIC DETERMINATION OF THULIUM IN PLUTONIUM–THULIUM ALLOYS
R. G. Hurley, E. A. Hakkila, and G. R. Waterbury 20 Oct. 1966 17 p refs
(Contract W-7405-ENG-36)
(LA-3549) CFSTI: HC$3.00/MF$0.65

Thulium is determined in plutonium by measuring the intensity of the thulium $L\alpha_1$ X-ray, correcting for the blank intensity, and comparing the corrected intensity with intensities measured for solutions containing known thulium concentrations. To prepare the solution for X-ray fluorescence measurement, duplicate 1-g samples are dissolved in hydrochloric acid and fumed repeatedly with nitric acid to eliminate chloride ion. Each solution is diluted to 5.00 ml with distilled water and nitric acid to provide a final acidity of 6.3M. This solution is irradiated in a nylon sample cell using a tungsten-target X-ray tube. The relative standard deviation of the method varies from 25% for 200 ppM of thulium to 1% for thulium concentrations greater than 1%. Only dysprosium, samarium, gadolinium, terbium, and iron interfere seriously with this method.
Author (NSA)

N67-19065# Los Alamos Scientific Lab., N. Mex.
THE SPECTROPHOTOMETRIC DETERMINATION OF TRACE AMOUNTS OF URANIUM IN HIGH-PURITY PLUTONIUM METAL
Ross D. Gardner and William H. Ashley 19 Oct. 1966 18 p refs
(Contract W-7405-ENG-36)
(LA-3551) CFSTI: HC$3.00/MF$0.65

Trace amounts of uranium in high-purity plutonium metal are determined spectrophotometrically with Arsenazo after an anion exchange seperation in hydrochloric acid. In the procedure described, dissolution of the metal sample in hydrochloric acid results in a solution in which both uranium and plutonium are in the (III) oxidation state. The addition of a small amount of bromine water oxidizes all of the uranium to the (VI) state, and any excess oxidizes plutonium to (V). When this solution is passed through a column of Dowex-1 resin, the uranium (VI) and plutonium (IV) are adsorbed, but nearly all of the plutonium, as plutonium (III), remains in solution and is washed through the column with concentrated hydrochloric acid. The adsorbed uranium and plutonium are readily eluted from the resin with dilute hydrochloric acid. When hydroxylamine is added to the eluate, the small amount of plutonium remaining is selectively reduced to plutonium (III), and the passage of the solution through the column a second time results in a quantitative separation of the uranium. The lower limit of detection of the method is 1 ppM, and the precision in the 0- to 10-ppM range is ± 1 ppM. The precision in the 10- to 100-ppM range is approximately ± 3 ppM.
Author (NSA)

N67-19067 Aciaries Reunies de Burbach-Eich-Dudelange S.A., Luxembourg.
INVESTIGATIONS ON THE INDUSTRIAL APPLICATION POSSIBILITIES OF ACTIVATION ANALYSIS FOR THE DETERMINATION OF OXYGEN AND EVENTUALLY OF NITROGEN AND HYDROGEN IN STEEL. PART III: DISCUSSION OF THE TESTS AND CONCLUSIONS TO BE DEDUCED FROM THE INVESTIGATION [ETUDE DES POSSIBILITES D'UTILISATION INDUSTRIELLE DE L'ANALYSE PAR ACTIVATION POUR LE DOSAGE DE L'OXYGENE ET EVENTUELLEMENT DE L'AZOTE ET DE L'HYDROGENE DANS LES ACIERS. TROISIEME PARTIE: DISCUSSION SES ESSAIS ET CONCLUSIONS A TIRER DE L'ETUDE]
N. Stoll, A. Wagner, and L. Goedert Brussels, EURATOM, 1966 28 p In FRENCH; ENGLISH summary
(Contract EURATOM-023-64-8 IRAL)
(EUR-3161.f, Vol. III) CFSTI: $3.00

Neutron activation and conventional equipments are compared for use in determining the oxygen content of steel during manufacturing. Installation costs are tabulated for various neutron activation dosages; and a comparison is made between the cost of one oxygen determination by neutron activation and by conventional means. It is concluded that neutron activation provides the only method of determining oxygen content in steel with the accuracy necessary for steel manufacturing. The proposed method is considered applicable to nitrogen and hydrogen determinations in industrial applications.
Transl. by M.W.R.

N67-19071# Gt. Brit. Ministry of Aviation, London.
A DECIMETER WAVE METHOD OF MEASUREMENT INDEPENDENT OF THE DETECTOR CHARACTERISTIC FOR DETERMINING THE COMPLEX DIELECTRIC CONSTANTS OF WATER AND AQUEOUS SOLUTIONS UP TO A LOSS FACTOR OF TAN δ=0.87. PART 1: THEORETICAL BASIC PRINCIPLES [EINE VON DER DETEKTOR CHARAKTERISTIK UNABHAENGIGE DEZIMETER-WELLEN MESSMETHODE ZUR BESTIMMUNG DER KOMPLEXEN DIELEKTRIZITAETSKON-STANTEN VON WASSER UND WASSRIGEN LOESUNGEN BIS ZUM VERLUSTFAKTOR TRAN δ=0.87. TEIL 1: THEORETISCHE GRUNDLAGEN]
H. J. Hoffman Nov. 1966 25 p refs Transl. into ENGLISH from Z. Physik. Chem. (Frankfurt), v. 224, no. 1/2, 1963 p 110–132
(TIL/T-5694) CFSTI: HC$3.00/MF$0.65

Theoretical principles are explained and equations are evolved for a method to measure the dielectric constants of aqueous solutions up to a loss factor of tan $\delta = 0.87$ for wavelengths between 10 and 50 cm. The σ determination is related to the measurement of short circuits between a double conductor in the liquid, for which a voltage node appears at the surface of the liquid, at a distance of one-fourth the wavelength. Only the transition of the voltage node on a measuring conductor is observed when a short circuit is slid along a double conductor immersed in water. Detector characteristics of the measuring probe circuit and field disturbances due to the probe do not enter into the measurement. Influence of intrinsic damping of the measuring arrangement is investigated, transformation behavior of two dielectric plates is treated, and a method for calibrating an adjustable conductor transformer is presented. M.W.R.

N67-19120*# California Univ., Los Angeles.
ANALYSIS OF ANCIENT SEDIMENTS AND EXTRA-TERRESTRIAL MATERIALS Semiannual Report, 1 Jun.–30 Nov. 1966
I. R. Kaplan 8 Feb. 1967 4 p
(Grant NGR-05-007-077)
(NASA-CR-82659) CFSTI: HC $3.00/MF $0.65 CSCL 07C

Studies designed to isolate and identify organic components of meteorites, and recent and ancient sediments are reported. The purpose of these studies in addition to the gathering of important scientific information, was to gain additional experience that could be applicable to the lunar sample recovery program. Focused upon were low molecular weight organic compounds that are normally volatile. Also studied was the distribution of naturally occurring stable isotopes of light elements. A description of analytical instruments and test equipment employed in studies of low boiling compounds and O^{18}/O^{16} ratios in sulfates, is presented. A dual-collecting high-precision mass spectrometer was developed for studies on the fractionation of C^{13}/C^{12} in methane and carbon dioxide in the products of metabolism of methane oxidizing and methane forming bacteria. In connection with isotope measurements, a vacuum line was established for the quantitative reduction of sulfate with graphite to CO_2. A gas collection-transfer manifold was constructed to eliminate the contaminative effects of greased stopcocks and polymer tubing. The use of cryogenic trapping of the organic gases using silica gel at liquid nitrogen temperatures is being tested. Also discussed is a gas chromatographic instrument for the separation and identification of the volatile compounds, and a method for quantitatively reducing barium sulfate to barium sulfide and carbon dioxide by reaction with graphite. S.C.W.

N67-19134*# Denver Research Inst., Colo. Chemical Div.
FLUORIDE ION REACTIONS OF FLUOROCARBON DERIVATIONS Final Report
John A. Young 1 Feb. 1967 16 p refs
(Grant NsG-518)
(NASA-CR-82445; DRI-2376) CFSTI: HC $3.00/MF $0.65 CSCL 07C

The relative reactivity of various unsaturated fluorocarbon derivatives toward cesium fluoride at temperatures up to 200° is described by the series $CF_3N{-}CF_2 > CF_2{=}CF_2 > CF_3CF{=}CF_2 > CF_2CFCl$, $CF_2{=}CCl_2 > CFCl{=}CFCl > CF_2{=}CHF$, $(CF_3)_2C{=}CF_2$, $CF_3CF{=}CFCF_3$, $CF_2CF{=}CFCF_2$. Of these, only $CF_3N{=}CF_2$ and $CF_3CF{=}CF_2$ gave products which could logically be ascribed to an ion mechanism. With mixtures of two compounds, the pairs $CF_2{=}CCl_2/CF_3CF{=}CF_2$, $CFCl{=}CFCl/CF_3CF{=}CF_2$, $CFCl{=}CFCl/CF_3N{=}CF_2$, and $CF_2{=}CF_2/(CF_3)_2C{=}CF_2$ gave independent reaction of one compound. In the presence of a solvent, some interaction between the two components was observed. Reaction of fluoro-anions with inorganic fluorides such as SF_4 and SOF_2 was successfully achieved and good yields of the 1:1 and 2:1 adducts were obtained. The structures of the adducts indicate that fluoride ion adds preferentially to carbon rather than to sulfur, in cases where competing reactions are possible. Author

N67-19158*# Hughes Aircraft Co., Culver City, Calif. Aerospace Group.
DEVELOPMENT OF IMPROVED STERILIZABLE POTTING COMPOUNDS AND CONFORMAL COATINGS FOR SPACE APPLICATIONS Annual Summary Report, 1 Jul. 1965–30 Jun. 1966
Norman Bilow 30 Jun. 1966 113 p refs
(Contract NAS8-5499)
(NASA-CR-82464; P66-184) CFSTI: HC $3.00/MF $0.65 CSCL 07C

Epoxysilicones, epoxysilazanes, n-methylaniline formaldehyde, siloxyurethanes, and epoxy and silicone resins have been investigated in a program to develop sterilizable electronic embedment materials and conformal coatings suitable for use in an aerospace environment. Synthesis procedures have been developed for the preparation of 1,3-bis(p-epoxypropylphenyl) tetramethyldisiloxane, the meta isomer of this compound, and various analogous diepoxy compounds of higher molecular weight. Trifunctional silazanes and n-methylaniline formaldehyde condensation products have been found to be excellent curing agents for epoxy resins, and various types of siloxypolyols have been made by the condensation of either trimethylolpropane or 1,4-bis(hydroxymethyl) diphenyloxide with diphenyldiethoxysilane, methylphenyldiethoxysilane, or phenyltriethoxysilane. A.G.O.

N67-19184# European Atomic Energy Community, Ispra (Italy). Chemistry Dept.
THE RADIOLYTIC AND PYROLYTIC DECOMPOSITION OF ORGANIC COOLANTS. VII: THE PYROLYSIS OF HIGH BOILING RESIDUE
G. Juppe and H. Rau Brussels, EURATOM, Nov. 1966 18 p refs
(EUR-3158.e) CFSTI: HC $3.00/MF $0.65

The kinetics of the thermal decomposition of high boiling residue originating from the in-pile radiopyrolysis of OM-2 were compared with those of pure m-terphenyl. At low conversions the rate of decomposition of high boiling residue was found to be approximately seven times faster than the rate of formation of high boilers from m-terphenyl. The main reaction products of the high boiler decomposition were benzene and diphenyl. There were no terphenyl isomers formed. The rate of the total gas production was about 100 times greater from high boiling residue than from m-terphenyl; and more saturated and unsaturated aliphatic hydrocarbons and less hydrogen produced. Author

N67-19186# Acieries Reunies de Burbach-Eich-Dudelange S.A., Luxembourg.
INVESTIGATIONS ON THE INDUSTRIAL APPLICATION POSSIBILITIES OF ACTIVATION ANALYSIS FOR THE DETERMINATION OF OXYGEN AND EVENTUALLY OF NITROGEN AND HYDROGEN IN STEEL. PART I: BIBLIOGRAPHICAL REPORT [ETUDE DES POSSIBILITES D'UTILISATION INDUSTRIELLE DE L'ANALYSE PAR ACTIVATION POUR LE DOSAGE DE L'OXYGENE ET EVENTUELLEMENT DE L'AZOTE ET DE L'HYDROGENE DANS LES ACIERS. PREMIERE PARTIE: RAPPORT BIBLIOGRAPHIQUE]
N. Stoll, A. Wagner, and L. Goedert Brussels, EURATOM, Nov. 1966 49 p refs In FRENCH; ENGLISH summary
(Contract EURATOM-023-64-8 IRAL)
(EUR-3161.f, Vol. I) CFSTI: HC $3.00/MF $0.65

Various non nuclear methods for the determination of oxygen, nitrogen, and hydrogen in steel are reviewed, and nuclear reactions best suited for the determination of the three elements are discussed. Reactions based on irradiation by charged particles are distinguished between reactions based on irradiation by neutrons or by gamma rays. The means of irradiation suitable for use on an industrial scale for determining the three elements are discussed, and methods for measuring induced activity, methods for neutron flu

monitoring, and sample transfer systems are explained. Calibration techniques are also reviewed. The analytical performances of using neutron activation analysis are discussed. The authors conclude that among the three elements under consideration, only oxygen can be determined in steel on an industrial scale by activation analysis by means of the reaction $O^{16}(n,p)N^{16}$ L.S.

N67-19189 Acieries Reunies de Burbach-Eich-Dudelange S.A., Luxembourg.

INVESTIGATIONS OF THE INDUSTRIAL APPLICATION POSSIBILITIES OF ACTIVATION ANALYSIS FOR THE DETERMINATION OF OXYGEN AND EVENTUALLY OF NITROGEN AND HYDROGEN IN STEEL. PART II: DESCRIPTION AND RESULTS OF THE TESTS [ETUDE DES POSSIBILITES D'UTILISATION INDUSTRIELLE DE L'ANALYSE PAR ACTIVATION POUR LE DOSAGE DE L'OXYGENE ET EVENTUELLEMENT DE L'AZOTE ET DE L'HYDROGENE DANS LES ACIERS. DEUXIEME PARTIE: DESCRIPTION ET RESULTATS DES ESSAIS]

N. Stoll, A. Wagner, and L. Goedert Brussels, EURATOM, Nov. 1966 69 p In FRENCH; ENGLISH summary
(Contract EURATOM-023-64-8 IRAL)
(EUR-3161.f, Vol. II) CFSTI: $3.00

Conclusions inferred from the bibliographical investigations are reviewed, and the method of sampling, machining and selecting the steel samples is explained. The motives of the selection of the analytical methods and of the laboratories retained for the investigations are stated and the working program followed is described. A description of the apparatus chosen for the determination of oxygen is given and the conditions for carrying out the tests are pointed out. All the results obtained during the tests are listed. The discussion of these results and the conclusions to be deduced therefrom are the object of the final report. Author

N67-19193 Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, Brussels (Belgium).

SYNTHESIS OF POLYPHENYL-RELATED REFERENCE PRODUCTS [SYNTHESE DE PRODUITS DE REFERENCE APPARENTES AUX POLYPHENYLES] Final Report

C. Beaudet, A. Marcq and J. Rygaert Brussels, EURATOM, Nov. 1966 32 p refs In FRENCH; ENGLISH summary
(Contract EURATOM-231-65-4 ORGC)
(EUR-3168.f) CFSTI: $3.00

Hydrogenated biphenyls were synthesized for use as reference compounds for the identification of radiolysis products obtained from benzene and diphenyl. Reactions leading to the formation of the three pure phenylcyclohexenes are reported: The Grignard reaction of phenyl magnesium bromide with cyclohexanone followed by the dehydration of the intermediate 1-phenyl-cyclohexanol (1) yielded phenyl-1-cyclohexene. The reaction of phenyl magnesium bromide with 2-bromo-cyclohexene gave phenyl-3-cyclohexene. Pure phenyl-4-cyclohexene was prepared by ring closure of styrene with butadiene. The thermal decomposition of the methylxanthates of phenyl-2-cyclohexanol and phenyl-4-cyclohexanol gave only mixtures of phenylcyclohexene isomers. Attempts to synthesize pure isomers of the phenylcyclohexadiene series are reported. The ultraviolet and infrared spectra of phenyl-1-, phenyl-3-, and phenyl-4-cyclohexene are described. Author

N67-19209# United Kingdom Atomic Energy Authority, Harwell (England). Research Group.

THE PROPERTIES OF HYDRATED TITANIUM DIOXIDE AND HYDRATED TANTALUM PENTOXIDE AS HIGH TEMPERATURE ION EXCHANGE MATERIALS

B. E. Chidley, F. L. Parker, and E. A. Talbot Oct. 1966 30 p refs
(AERE-R-5220) HMSO: 4s 6d

Hydrated titanium dioxide and hydrated tantalum pentoxide were studied for possible use as ion exchange materials at 300°C. Evidence suggests that after five hours at 300°C, hydrated titania loses all its ion exchange capacity, and it is therefore not likely to be of great value for clean-up in pressurized water reactors at the full operating temperature of the primary circuit. It was also found that it might have a limited usefulness in water systems operating at a lower temperature of about 100°C. At 300°C, tantala had an ion exchange capacity in the region 0.55 to 1.37 meq/g. Its possible use in water reactor clean-up systems has been considered in a previous study in which it was concluded that it would have value only if capacities of at least 1 meq/g could be guaranteed. Tantala appears to be too expensive to justify its use in a Powdex type process unless a means to regenerate it is found. S.C.W.

N67-19211# United Kingdom Atomic Energy Authority, Harwell (England). Research Group.

TWENTY-FIVE YEARS OF NUCLEAR FISSION. METHODS AND RESULTS OF CHEMICAL STUDIES. 2.

G. Herrmann Mar. 1966 49 p refs Transl. into ENGLISH from Radiochimica Acta (USSR), v. 4, 1965 p 173–188
(AERE-TRANS-1057) HMSO: 7s

Methods and results of chemical studies on low-energy fission of heavy nuclei are reviewed. Presented are data on methods used for direct and indirect detection of fission products; radiochemical methods, mass spectrometric methods, and methods for the determination of fission rates and absolute fission yields; special methods for studying nuclear charge distribution as independent yields of shielded fission products and fractional yields of fission chain members; and physical methods for studies of mass and charge distribution. Included are general remarks on fission yields. S.C.W.

N67-19220# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Stuttgart (West Germany).

PREPARATION OF NITROGEN FLUORIDES BY ELECTROLYSIS [HERSTELLUNG VON STICKSTOFFFLUORIDEN DURCH ELEKTROLYSE]

E. W. Schmidt Oct. 1966 39 p refs In GERMAN; ENGLISH summary
(DVL-560; DLR-FB-66-65) CFSTI: HC $3.00/MF $0.65

Nitrogen trifluoride (NF_3) was needed for the synthesis of other nitrogen fluorides. It was prepared by: electrolysis of molten ammonium bifluoride NH_4HF_2, electrolysis of urea in anhydrous hydrogen fluoride solution, and electrolysis of guanidine in anhydrous hydrogen fluoride solution. An experimental evaluation of these different methods shows that in spite of danger arising from formation of explosive by-products (F_2NH) the first method gives optimum results. The separation of by-products (method 2 and 3) from the main product NF_3 is very difficult. Author

N67-19228# Naval Research Lab., Washington, D. C.

THE EFFECTS OF A JET FUEL ANTI-ICING ADDITIVE ON FUEL TANK LININGS Final Report

G. E. Rohl 7 Oct. 1966 18 p refs
(NRL-6445; AD-644563) CFSTI: HC $3.00/MF $0.65

Ethylene glycol monomethyl ether (methyl cellosolve), a good solvent for organic polymers, has been evaluated by the Navy as a jet fuel anti-icing additive. The effect(s) which such an additive might have on organic coatings applied to the interior of large underground fuel storage tanks could influence any decision on its adoption. Steel and concrete panels coated with lining materials currently used by the Navy were exposed to aqueous solutions of the anti-icing additive in the presence of JP-5 for up to two years. Results indicate that 20 to 60% additive concentrations in the water phase inhibited blister size and/or density by

comparison with water immersion alone. Although the presence of additive in the test media resulted in a slight softening of the type 53 lining for concrete tanks, there is no significant difference in adhesion of this film to concrete when immersed in water alone or with additive concentrations up to 60%. No adverse effect of the additive on linings applied to steel or concrete is anticipated in the normally encountered concentrations of 20 to 40%. It is concluded that the presence of this anti-icing additive in concentrations normally to be encountered could extend the service life of the coatings. Author (TAB)

N67-19248# Bureau of Mines, Reno, Nev. Metallurgy Research Center.
REACTIONS OF MANGANESE WITH SILICA
Henry G. Iverson and Eben L. Singleton 1967 22 p refs
(BM-RI-6905)

Solid state reactions of manganese with silica were investigated in high-temperature tests. Reactions of 0.5 to 4.0 moles manganese (Mn) with 1 mole silica (SiO_2) at 1,100°C and of 2.0 Mn:SiO_2 mole-ratio mixtures at 1,000° to 1,150°C yielded products consisting of a slag phase and a metallic phase. At 1,100°C, the slag phase from reactions of the low Mn:SiO_2 mole-ratio mixtures was composed of SiO_2 and rhodonite ($MnSiO_3$), and the slag phase from the high Mn:SiO_2 mixtures was composed of $MnSiO_3$ and tephroite (Mn_2SiO_4). The metallic phase from the corresponding low Mn:SiO_2 mole-ratio reactants consisted of two manganese silicides, Mn_5Si_3 and Mn_3Si; from the high Mn:SiO_2 mixtures, it was Mn and the manganese silicide (Mn_5Si). For the higher mole ratios of Mn:SiO_2 the manganese content in the metallic phase increased, while the manganese and silica contents of the slag phase remained nearly constant. The slags did not contain free or uncombined manganese oxide (MnO). For the 2.5 to 4.0 Mn:SiO_2 mole-ratio mixtures reacted at 1,100°C, the maximum quantities of silica reduced and of the manganese in the slag appeared to become asymptotical at about 41 and 48 percent, respectively. A brominating procedure was developed that was highly selective in removing the metallic constituents from the reaction product, leaving the slag phase as residue. Author

N67-19249# Bureau of Mines, Reno, Nev. Metallurgy Research Center.
HEATS OF FORMATION OF YTTERBIUM AND THULIUM TRICHLORIDES
John M. Stuve 1967 13 p refs
(BM-RI-6902)

Standard heats of formation of $YbCl_3$ (c) and $TmCl_3$ (c) were measured by solution calorimetry. Heat of solution data are given for ytterbium and thulium metals and corresponding anhydrous trichlorides in 4.360 molal hydrochloric acid. The derived standard heats of formation of $YbCl_3$ (c) and $TmCl_3$ (c) were $-229,370\pm720$ and $-235,820\pm400$ cal/mole, respectively, at 298.15°K. The resulting heats of formation for $YbCl_3$ and $TmCl_3$ are about 1 kcal and 6.3 kcal more negative than previously published values. Author

N67-19252# Bureau of Mines, Reno, Nev. Metallurgy Research Center.
EXTRACTION OF EUXENITE METAL VALUES BY FUSION WITH AMMONIUM SULFATE OR AMMONIUM BISULFATE
Van E. Shaw and Roald E. Lindstrom 1967 17 p refs
(BM-RI-6906)

Fusion of an 88-percent euxenite concentrate with ammonium sulfate was investigated. Reaction for 4 hours at 400°C results in conversion of both the rare-earth elements and the titanium–columbium components to water-soluble compounds. Similar results are obtained with ammonium bisulfate. Stirring the fusion mass decreases the reaction time substantially. Alternatively, treating the fusion product with a 3-hour, 650°C calcining step renders the non-rare-earth constituents insoluble, thereby allowing selective leaching of a pure rare-earth fraction with an overall yield of 97 percent. Author

N67-19341# Oak Ridge National Lab., Tenn.
CHEMISTRY DIVISION Annual Progress Report, Period Ending 20 May 1966
Sep. 1966 200 p refs
(Contract W-7405-ENG-26)
(ORNL-3994) CFSTI: HC $3.00/MF $0.65

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N67-19342# Oak Ridge National Lab., Tenn.
NUCLEAR CHEMISTRY
In its Chem. Div. Sep. 1966 p 1–26 refs (See N67-19341 08-06) CFSTI: HC $3.00/MF $0.65

The following studies are reported: (1) neutron capture cross section of the 6.75-day U 237; (2) reactor neutron cross sections for the isotopes of Cd 110, Cd 111, and Cd 112; (3) thermal neutron corss sections and resonance integrals of 36-hr Rh 105, La 139 and La 140, and 7.5-day Ag 111; (4) nuclear charge distribution in fission: yields of Pd 115, Ba 143 and Ba 144, and Mo 103, Mo 105, and Mo 106 from the thermal-neutron fission of U 235; (5) gamma rays in compound-nucleus excitation produced by alpha particle bombardment of Nb 93, Zr 94, and Cd 114; (6) level structures of Zr 94 and Mo 92; (7) decay of Tc 94 isomers to levels in Mo 94; (8) decay of 12.8-hr I 130g and 8.8-min I 130m; (9) energy levels of W 184 populated in the decay of Ta 184; (10) decay properties and schemes of Eu 152, Br 80m, and Pr 136 and Pr 137; and (11) gamma ray intensities in the decay of Eu 154. K.W.

N67-19343# Oak Ridge National Lab., Tenn.
ISOTOPE CHEMISTRY
In its Chem. Div. Sep. 1966 p 27–39 refs (See N67-19341 08-06) CFSTI: HC $3.00/MF $0.65

Brief reports are presented regarding the following work: (1) non-aqueous microtitration for the quantitative determination of dibenzoylmethane and other weak acids; (2) determination of temperature dependence and fractionation in boron isotope reactions; (3) carbon isotope effect in the depolymerization of paraldehyde; (4) an unsuccessful attempt to form an addition compound by reacting boron halides with CO; (5) isotope effects in the alkaline reduction of NO_3^-, NO_2^-, and NH_2OH by Fe(II); (6) operation and production of an oxygen isotope enrichment facility; (7) Raman and infrared spectroscopy studies involving carbon and boron isotopic fractionation factors for exchange reactions, the spectra of the BF_3 complex with dimethyl sulfide and the isotopic exchange of the complex with BF_3, and the spectra of the hexafluoride ions of silicon, germanium, and tin; (8) nuclear magnetic resonance spectroscopy involving $(C_2H_5)_2O.(BF_3)n$, BrF_3, complexes between Sn(IV) and F^-, SbF_5, and AsF_5; (9) isotopic mass spectro

determinations of samples containing boron, carbon, oxygen, and nitrogen; and (10) uses and effects of Coriolis coupling and centrifugal distortion constants in force-constant determinations.
K.W.

N67-19344# Oak Ridge National Lab., Tenn.
RADIATION CHEMISTRY
In its Chem. Div. Sep. 1966 p 40–52 refs (See N67-19341 08-06) CFSTI: HC $3.00/MF $0.65

The following work is discussed: (1) progress in a program of pulse radiolysis and flash photolysis, in which equipment development and preliminary studies with aqueous solutions are covered; (2) observation of hydrogen yields in the Co 60 gamma radiolysis of aqueous N_2O-saturated 2-propanol, sodium formate, and sodium nitrate solutions; (3) a study of the postirradiation reduction of cerium(IV) in the Co 60 gamma radiolysis of concentrated nitrate solutions, with investigations of the dependence of G_{HNO_2} on sodium nitrate concentration and the effect of 2-propanol on $G(Ce^{III})$ and G_{HNO_2}; (4) an examination of the relative effectiveness of several added gases on the radiolysis of carbon dioxide in order to identify the intermediates involved; (5) measurement of the relative radiolytic yields for hydrogen atom formation on several adsorbents and absolute yields for three other radiolyses on adsorbents (decomposition of nitrous oxide, of isopropanol, and of formic acid); and (6) observation of the effects of dose rate and solid-liquid phase change in the radiolysis of molten and crystalline $LiNO_3$ to oxygen gas and nitrate ion by Co 60 gamma rays.
K.W.

N67-19345# Oak Ridge National Lab., Tenn.
ORGANIC CHEMISTRY
In its Chem. Div. Sep. 1966 p 53–64 refs (See N67-19341 08-06) CFSTI: HC $3.00/MF $0.65

A study was made of the rate at which carbonium ions interconvert as compared with the rates at which they react with entering groups or eject protons to form products in a system known to proceed through classical ionic intermediates. Carbon-14 labeling and NMR spectroscopy were used. The concept that "internal return in carbonium ion processes necessarily alters the product ratios" was studied both mathematically and chemically and shown to be incorrect. The mechanism by which hydrogens migrate during solvolysis reactions of the norbornyl system was partially elucidated. Three rearranged products were formed when 2-exo-hydroxy-2-phenyl-3-exo-norbornyl-5,6-exo-d_2 tosylate was treated with boiling acetic acid. Data are presented showing how 2-phenyl-norbornane-2,3-cis-exo-diol-5,6-d_2 reacts, when treated with concentrated sulfuric acid, to give 3-endo-phenylnorbornanone-exo-5-anti-7-d_2, a result of intramolecular rearrangement involving a stereospecific migration of deuterium. The deamination of 3-endo-amino-2-exo-phenyl-norbornanol-2 in glacial acetic acid led to the production and isolation of six compounds in approximately 85% yield. It was shown that during the hydrolysis of 2-exo-hydroxy-2-phenyl-3-exo-norbornyl tosylate, one of the products, 2-exo-phenylnorbornane-2-endo-5-exo-diol, is formed as a result of two consecutive 1,2 hydride shifts. 2-Ethyl-hexanohydroxamic acid was prepared and tested as a solvent for cations in equilibrium distribution studies. With this hydroxamic acid, a selectivity for zirconium, niobium, and hafnium over cobalt, uranyl, thorium, and ferric iron was found.
Author (NSA)

N67-19346# Oak Ridge National Lab., Tenn.
CHEMISTRY OF AQUEOUS SYSTEMS
In its Chem. Div. Sep. 1966 p 65–87 refs (See N67-19341 08-06) CFSTI: HC $3.00/MF $0.65

The activity coefficient of HCl in HCl–$BaCl_2$ mixtures was studied to 175°C. The solubility of Ag_2SO_4 was measured in 0.056, 0.109, and 0.242 M $AgNO_3$ solutions in the temperature range from 25 to 150°C. The solubility of $La_2(SO_4)_3$ was measured in 0.234, and 0.714M H_2SO_4 solutions in the temperature range from 120 to 175°C. Accurate density measurements were made of aqueous solutions of NaCl and LiCl at 5°C and of LiCl at 35°C. The hydrolytic polymerization of Th(IV) in perchlorate media was investigated by equilibrium ultracentrifugation from 0 to 3 hydroxyls bound per thorium, n; up to n=2.5 aggregated species were of low molecular weight and appeared to be in a chemical equilibrium with one another. A systematic study of the cation exchange behavior of elements in dilute to concentrated HBr solutions was carried out with a sulfonic acid resin. The effect of the structure of quaternary ammonium cations on their thermodynamic properties in aqueous solutions was investigated by measurements of osmotic coefficients and enthalpies of dilution with solutions of several quaternary ammonium halides at 25°C. Salt filtration was observed when solution was forced by pressure through a porous glass, and rejection was enhanced by increasing the ion exchange capacity of the glass. Measurements of isopiestic ratios of solutions having the solute composition of seawater to NaCl solutions indicated that osmotic coefficients of seawater and its concentrates can be computed from empirical equations by insertion of seawater concentration in terms of ionic strength. Recent work at 25°C showed that the osmotic coefficient of sea salt solutions to saturation could be expressed very well by a Debye–Hückel term plus a power series in ionic strength, where the coefficients of the series were evaluated from measurements on pure NaCl solutions.
Author (NSA)

N67-19347# Oak Ridge National Lab., Tenn.
ELECTROCHEMICAL KINETICS AND ITS APPLICATION TO CORROSION
In its Chem. Div. Sep. 1966 p 88–94 refs (See N67-19341 08-06) CFSTI: HC $3.00/MF $0.65

Further studies on the inhibition of corrosion of iron and steel showed that inorganic substances of the general formula XO_4 exert a noncathodic effect that greatly facilitates the passivation process. A mechanism is proposed, which accounts for the complex electrochemical behavior of iron in the presence of adsorbed anionic inhibitors. Studies with a rotating disk electrode assembly on the dissolution of Zr in HF–HCl and HF–HNO_3 mixtures showed that at potentials below the pitting potential in chloride media the rates of dissolution in the two solutions are identical. Other experiments in HF–H_3PO_4 solutions disclosed a reduction in dissolution rate by several orders of magnitude; PO_4 ion inhibited the dissolution reaction by HF in a manner similar to the SO_4 ion. The rate of the anodic dissolution reaction of aluminum in alkaline NaCl solutions was measured as a function of pH, electrode potential, and time by use of a rotating disk electrode assembly. Experiments were initiated on electrochemical aspects of the formation and growth of pits on titanium in chloride solutions. Polarization curves of Ti and some of its alloys were measured in chloride solutions at temperatures up to 200°C by use of a Ti loop facility equipped for electrochemical studies. In the presence of a sufficient quantity of chloride ions, Ti alloys exhibited a pitting potential, which in some cases is low enough to allow pitting attack to proceed spontaneously. Electrochemical aspects of the corrosion of types 5454 and 6061 Al alloys were studied in 1M NaCl at 150°C in Ti loop facilities. Changes in the polarization curves of anodic and cathodic processes occurring at the Al–electrolyte interface with pH provided a kinetic explanation for the existence of a minimum corrosion rate in chloride media.
Author (NSA)

N67-19348# Oak Ridge National Lab., Tenn.
NONAQUEOUS SYSTEMS AT HIGH TEMPERATURES
In its Chem. Div. Sep. 1966 p 95–105 refs (See N67-19341 08-06) CFSTI: HC $3.00/MF $0.65

In constrast to earlier suggestions it was shown that aluminum chloride and zirconium tetrachloride form a simple eutectic system without a miscibility gap in the liquid state. In agreement with X-ray diffraction data for thermal expansion, drop-calorimetric

measurements of the heat contents of potassium and thallium sulfates showed these diisomorphous salts to differ significantly with respect to the transition from an orthorhombic (pseudohexagonal) to a hexagonal crystal structure. While in potassium sulfate most of this change occurs isothermally at 584°C, the corresponding change in thallium sulfate has a very small isothermal part and is predominantly a gradual pretransitional process. The difference is attributable to the high polarizability of the Tl^+ ion. With the technique that allows emf measurements in molten metal–salt systems corrosive to ceramics, a study of the Ce–$CeCl_3$ and Nd–$NdCl_3$ systems was made. A similarity in the emf results was found in contrast to the quite distinct differences in the two systems as shown by phase equilibria and electrical conductivity studies. An explanation correlating the various observations with the extent of the dissociation $M^{2+} \rightarrow M^{3+} + e^-$ is presented. The study of metal–salt miscibility in systems of divalent metals such as the alkaline earths was continued with a determination of the phase equilibria between strontium metal and its halides. As expected, the behavior of strontium was found to be intermediate between that of calcium and barium, though closer to the latter. Critical solution temperatures ranged from 1056 to 1106°C. The study of the miscibility of metals with their fluorides showed solid barium fluoride to be as much as four times as soluble in liquid barium metal as solid calcium fluoride in liquid calcium. Separation into two liquids did not occur in either system. Following the trend in miscibility, the solubility of magnesium metal in molten magnesium fluoride was found to be as low as 0.5 mole % at 1256°C, the melting point of the salt. Author (NSA)

N67-19349# Oak Ridge National Lab., Tenn.
CHEMICAL PHYSICS
In its Chem. Div. Sep. 1966 p 106–144 refs (See N67-19341 08-08) CFSTI: HC $3.00/MF $0.65

Summary reports are given of research in the following topics in chemical physics: the absorption spectrum of ammonia in the near-infrared region as a function of temperature; the absorption spectrum of normal hexane and cyclohexane in the near-infrared region as a function of temperature; calorimetry, including the heat capacity of potassium hexaiodorhenate(IV) from 6° to 320°K, high temperature enthalpy of potassium pertechnetate, and enthalpy and free energy of formation of the hexachlororhenate(IV) ion and its enthalpy of hydrolysis; microwave and radio frequency spectroscopy, e.g., paramagnetic resonance studies of single crystals and of free radicals formed in liquids during ultraviolet photolysis; neutron and X-ray crystallography, e.g., a neutron diffraction study of the cubic phase of xenon hexafluoride and X-ray diffraction studies of liquids; molecular beam studies, e.g., elastic scattering in H–He systems and collisional excitation of vibrational levels in H; and mass spectrometry and related techniques. L.E.W.

07 COMMUNICATIONS

Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation.

N67-18209# Federal Aviation Agency, Atlantic City, N. J. Test and Evaluation Div.
EXPERIMENT WITH DOPPLER VOR MONITORS Final Report
Virgil E. Willey Oct. 1966 16 p
(RD-66-49)

This report describes a Doppler (VOR) very high frequency Omnidirectional Range sideband antenna monitor. The monitor utilizes a band-pass spectrum analysis technique for the detection of a faulty sideband antenna. The ability to detect a sideband antenna fault deletes the requirement of two of the three VOR monitors presently used in the monitoring of the Doppler VOR. Author

N67-18264# Joint Publications Research Service, Washington, D. C.
SPACE-TIME CORRELATION FUNCTION OF SCATTERED FIELDS
K'o-Chung Liu *In its* Transl. on Communist China: Sci. and Technol., No. 360 4 Jan. 1967 p 1–18 refs Transl. into ENGLISH from Shang-Hsueh Hsueh-Pao (Peking), v. 1, no. 2, Dec. 1964 p 76–83 (See N67-18263 08-34) CFSTI: $3.00

A method to find the statistical properties of scattered fields caused by scatterers is established. The chief points of this method are the applications of the theory of random time-varying networks and the theory of streams of random events in the queueing theory. With the help of this method, the equations of the space-time correlation function of scattered field are established. Comparing with the equations which were established by others, there are more factors, such as the random motions of scatters, the statistical dependence between these motions, the nonhomogeneity (including stratified nonhomogeneity) of propagation medium, the dispersion and absorption by the medium, the differences between scatterers, and the like, taken into account in these equations. These factors cannot be neglected in most practical problems. Moreover, the functional forms of the transmitted signals, directivity of radiation, spatial distribution of scatters, scattering coefficients, etc., are unrestricted in these equations. Author

N67-18296# Ballistic Research Labs., Aberdeen Proving Ground, Md.
A SOLID STATE PHASE-LOCKED TRACKING FILTER
J. Schmidt May 1966 62 p ref
(BRL-MR-1759; AD-643083) CFSTI: HC $3.00/MF $0.65

The report describes the operation and application of a solid state, 8 mc/s phase-locked, tracking filter which is used in conjunction with a three-frequency receiving system and data circuits to measure dispersive Doppler and attenuation of electromagnetic waves due to the ionosphere. Primary design specifications required that the tracking filter automatically lock on to the incoming signal within one second, provide a 30 db improvement in the signal-to-noise ratio of the receiver output signal, and not exceed 3 degrees phase error over the expected Doppler frequency range of plus or minus 3 kc/s. These specifications were met in laboratory tests. Author (TAB)

N67-18300# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
USING uhf OF RADIO STATIONS FOR TRANSMITTING INFORMATION
P. P. Belogrivtsev 25 Apr. 1966 8 p Transl. into ENGLISH from Vestn. Protivovozdushnoy Oborony (USSR), no. 4, 1964 p 39–41
(FTD-TT-65-1816; TT-66-62422; AD-640258) CFSTI: HC $3.00/MF $0.65

In order to achieve ultrahigh frequency transmission over a distance exceeding 18 km, a double square directional antenna was developed to be used on radio stations. The antenna was fastened to the mast at about 30 m height and used its own amplifiers for energy attenuation in the feeders and for increased radiation power. Experimental transmission with this antenna showed dependable work over distances up to 80 km. G.G.

N67-18305*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ELECTROSTATIC CHARGE DENSITIES ON AN ELECTROOPTICAL STAR TRACKER
N. C. Adams, E. M. Keberle, and W. Silsby *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 10–15 *ref* (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

Results of IBM 7090 computer computations of electrostatic charge densities on axial symmetric electrodes of an electro-optical star tracker are presented. S.C.W.

N67-18308*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
A NOTE ON STRATONOVICH'S EQUATION FOR THE CONDITIONAL PROBABILITY DISTRIBUTION OF THE STATE OF A NONLINEAR SYSTEM, WITH APPLICATION TO NONLINEAR FILTERING
S. R. McReynolds *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 22–27 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

The Stratonovich equation for the conditional probability distribution of a system, given nonlinear measurements, was rederived. It has shown to be consistent with the Kalman filter, whereas Kushner's equation does not appear so. Stratonovich's equation was then used to obtain an approximate filter for nonlinear equations. It is seen to resemble the Kalman filter, with the appearance of several additional terms due to the nonlinearities of the functions involved. Recent suggestions have been made by Denham and Pines to modify the Kalman filter to correct for nonlinearities. The approximate filter obtained contains several such terms. It is felt that the effect of these terms should be investigated before higher order approximation schemes are tried. Author

N67-18309*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ON THE FIRST OCCURRENCE OF SPECIFIED SEQUENCES
C. B. Solloway and H. Lass *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 27–30 (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

Given a sequence of zeros and ones transmitted with probabilities p and q=1−p, a solution is presented for the case of all possible subsequences of length 3. Focused upon is the probability that a specified subsequence occur for the first time on the nth transmission, and the statistics associated with this probability. S.C.W.

N67-18340*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RF TECHNIQUES: APPLICATION OF DC POTENTIOMETER INSERTION LOSS TEST SET TO MM WAVELENGTHS
D. Oltmans and C. T. Stelzried *In its* Space Programs Sum No. 37–42, Vol. IV 31 Dec. 1966 p 171–173 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

Details are given on a thermistor mount which was developed to reduce the problems encountered when the dual channel insertion loss test set was used at 90 GHz. Elimination of the waveguide transition, and the added capability of externally adjusting the impedance of the mounts resulted in a greatly improved match between the thermistor mount and the E-band waveguide sections. A method for thermally adjusting the compensation thermistor was also devised. This involves adding a hot leak to one of the wires connecting the thermistor to the support. Because of the small size of the rectangular slit in which the thermistor is suspended, a fine paint spray is used instead of epoxy or adjustment screens. For added protection against sensitivity to thermal environment changes, the mount is insulated and has a stainless steel waveguide section to reduce thermal conduction. M.G.J.

N67-18341*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
LINEAR BIT PACKING DENSITY ON STANDARD INSTRUMENTATION MAGNETIC RECORDING TAPES
W. G. Clement *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 174–176 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

Criteria are developed for evaluating the bit resolution capability of magnetic tapes used in digital nonreturn-to-zero (NZR) recording systems. Output signals from seven different tapes were measured at various bit densities and the values plotted. For each tape sample, the record current was set at a value which gave the maximum output at a bit density sufficiently low so that no reduction in amplitude due to bit crowding occurred. These data, adjusted to a common level at the low densities, are also plotted. Additional tests were run on the same samples with record current values chosen so that a record frequency of f Hz completely obliterated signals previously recorded at 2f Hz, and vice versa. Determination of these current values was an iterative process, and the worst case proved to be one with the higher frequency signal obliterating a recording made with the lower frequency signal. Emphasis is placed on the importance of establishing test conditions which closely approximate the eventual system conditions when evaluating any single component of a magnetic recording system. M.G.J.

N67-18343*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
HIGH IMPACT ANTENNA STUDY: CUPPED TURNSTILE ANTENNA
K. Woo *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 180–181 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

Summary information is presented on the development of an indirect type high impact antenna which consists of a pair of aluminum turnstiles backed by a cylindrical aluminum cup. It is reported that the antenna successfully sustained a 10,000-g shock imparted into its mounting structure, and showed a relatively higher gain and lower axial ratio than other high impact antennae. Radiation patterns before and after impact are depicted. M.G.J.

N67-18345*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
MARINER S-BAND TURNABOUT RANGING TRANSPONDER IMPROVEMENT PROGRAM
L. M. Hershey *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 183–189 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

The S-band turnaround ranging transponder used on the Mariner Mars 1964 spacecraft is described, and the problems encountered with the original design are discussed. These are categorized as system problems, and problems peculiar to individual modules. Also discussed is the improvement program being undertaken to analyze and correct these problems. Improved versions of the first and second i.f. amplifiers and the X30 multiplier were breadboarded; partial breadboards were built on the mixer–preamplifier, AGC detector, VCO, and auxiliary oscillator. Ranging and AGC performance and the self-lock phenomenon were analyzed, and ranging delay variation measurements are being performed. It is pointed out that the program is being coordinated closely with the Mariner Mars 1969 project's transponder program. M.G.J.

N67-18346*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
BLOCK CODING AND SYNCHRONIZATION STUDIES: RAPID ACQUISITION SEQUENCES
J. J. Stiffler *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 191–197 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

A class of binary sequences, which lend themselves to rapid acquisition when serial binary decisions are prescribed, is presented. It is shown that these sequences suffer a degradation of only a factor of $2/\pi$ (in power) relative to the optimum (nonbinary) acquirable sequences under these constraints. The ratio of the

time needed to acquire one of these sequences of length N to that needed using a shift register sequence of the same length was found to be approximately $2(\log_2 N)\log_2(\log_2 N)/N$. This ratio obviously decreases very rapidly as N increases and is already only 3/16 when N = 256. Several techniques for increasing the strength of the clock component in the composite sequence are explored. Author

N67-18347*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
COMBINATORIAL COMMUNICATION: A NEW INTERPRETATION OF A BASIC COMBINATORIAL FORMULA
S. W. Golomb *In its* Space Programs Sum. No. 37-42, Vol. IV 31 Dec. 1966 p 179-198 ref (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

Four answers are listed to the basic problem of elementary enumeration involving the number of samples of size r from a population of size k, with or without replacement, and with or without regard to order. Based on a different interpretation of the underlying situation, another proof is offered to the formula: with replacement and disregarding $(k+r-1)/r$. M.G.J.

N67-18348*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
COMMUNICATION SYSTEMS DEVELOPMENT: MINIMIZING RANGE CODE ACQUISITION TIME
R. C. Tausworthe *In its* Space Programs Sum. No. 37-42, Vol. IV 31 Dec. 1966 p 198-200 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

Coding to minimize acquisition time is studied, under the constraint that all periods be different. Formulas are derived to determine the probability of correct acquisition, and the minimization of the acquisition time. M.G.J.

N67-18349*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
COMMUNICATION SYSTEMS DEVELOPMENT: CYCLE SLIPPING IN PHASE-LOCKED LOOPS
R. C. Tausworthe *In its* Space Programs Sum. No. 37-42, Vol. IV 31 Dec. 1966 p 200-205 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

A model is developed which is applicable to the determination of the mean first slip times for a loop of arbitrary degree. It is shown that the expected first slip time satisfies a linear differential equation reducible to one of first order, and to which formal solutions are easily given. The derivation follows directly from a random walk model not restricted to Markov type processes. The expectation valid for loops of any order is approximated, along with the specific behavior of second order loop cycle slipping. M.G.J.

N67-18431* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
DESIGN CONSIDERATIONS IN RADIATION HARDENING OF TELEMETRY AND CONTROL CIRCUITRY IN SPACECRAFT
R. L. Van Allen [1965] 15 p refs Presented at the 15th IEEE Ann. Conf. on Nucl. and Space Radiation Effects, Ann Arbor, Mich., 12-15 Jul. 1965
(NASA-TM-X-57092) CFSTI: $3.00 CSCL 09F

The failure of the telemetry encoder and electronic data system of Explorer XV due to radiation effects is discussed. A radiation hardening study was conducted to determine if the life of spacecraft electronics could be extended to that of p-n solar cells, and to determine the failure mode of Explorer XV. Only a few subsystems were found deficient and component changes were made in the telemetry encoder and several subcommutating networks. No clues to Explorer XV's transmission failure were found. The component changes were incorporated into Explorer XXVI. The spacecraft was launched and is still operational. Spacecraft electronics systems are now being designed with full consideration of the radiation environment to be expected in the spacecraft's proposed orbit. Examples of close tolerance design are given. The use of MOSFETs to reduce circuit parts count and power is discussed along with their radiation vulnerability. However, due to the savings in parts and power, extra shielding weight can be included in the spacecraft to protect the MOSFETs. The results of tests to determine the radiation damage properties of MOSFETs are given. R.N.A.

N67-18453# Syracuse Univ. Research Inst., N. Y.
ADAPTIVE SONAR SYSTEMS AND PARALLEL PROCESSING, PART 7
J. G. Rudolph *In its* Theory of Adaptive Mech. Nov. 1966 p 124-135 refs (See N67-18447 08-08) CFSTI: HC $3.00/MF $0.65

The study of the applicability of parallel processing to adaptive sonar (radar) systems has led to the specification of target acquisition and the optimization of detection by adaptive methods as two potentially viable areas. Examples to illustrate this need are included with the greater effort being made on adaptive signal design for optimum detection. Actual results from the use of the iterative array computer to resolve one or more of the example problems have not been obtained at this time. Author

N67-18491* Volt Technical Corp., Washington, D. C.
INVESTIGATION OF THE ATMOSPHERE BY RADIOASTRONOMICAL METHODS AT SMALL ANGLES ABOVE THE HORIZON [ISSLEDOVANIYE ATMOSFERY NA MALYKH UGLAKH NAD GORIZONTOM RADIOASTRONOMICHESKIMI METODAMI]
K. S. Stankevich and O. N. Shipulya 19 Jan. 1967 9 p refs Transl. into ENGLISH from Radiotekhn. i Elektron. (Moscow), v. 12, no. 1, 1967 p 13-18
(Contract NAS5-12487)
(NASA-CR-82094; ST-AI-RA-10554) CFSTI: $3.00 CSCL 20N

Theoretical and experimental investigations of atmosphere's radio emission temperature have been conducted in the decimeter band for angles from 0°30' to 10°. Effective lengths are found for the absorption coefficient. Refraction attenuation of antenna amplification, found for angles <2.5° above horizon, increases as the altitude decreases. Thus, for an antenna with half-power level pattern near 40' at heights 0°30', the amplification drops by 60%. It was shown that at refraction attenuation of the amplification, the antenna scattering remains the same as for a uniform medium. Author

N67-18516 Joint Publications Research Service, Washington, D. C.
THE DEVELOPMENT OF A SOUND SPECTROGRAM
Pei-Kang Fan *In its* Transl. on Communist China's Sci. and Technol. No. 356 20 Dec. 1966 p 55-58 ref (See N67-18511 08-34) CFSTI: $3.00

Design and operational data are presented on a sound spectrogram device for the analysis of language. The type described provides for simultaneous analysis and display, which results in a fast, convenient, and direct way for treating large amounts of data at one time. Basically, the signal is amplified through the first stage; with proper weighting and with construction of the activity range, and through filtration by use of a filter set, it is then amplified and detection is made. The recording can be photographed with a movie camera, or a special circuit within the instrument can be used. A schematic diagram is included. The sound spectrogram obtained from the device is also discussed. It is pointed out that the entire bandpass frequency can be based on sound characteristics; analysis requirements can be divided into a number of channels. M.G.J.

N67-18520*# RAND Corp., Santa Monica, Calif.
MULTIPLE-ACCESS TECHNIQUES FOR COMMUNICATION SATELLITES: ANALOG MODULATION, FREQUENCY-DIVISION MULTIPLEXING, AND RELATED SIGNAL PROCESSING METHODS
E. E. Reinhart Nov. 1966 279 p refs
(Contract NASr-21)
(NASA-CR-82014; RM-5117-NASA; NASr-21(02)) CFSTI: HC $3.00/MF $0.65 CSCL 17B

The theory of several modulation, multiplexing, and signal processing techniques are discussed. Signal-to-noise relationships are emphasized, and expressions are presented for the performance in terms of cost in rf bandwidth and power for any combination of techniques. Modulation techniques covered include amplitude, double-sideband suppressed carrier amplitude, single-sideband suppressed carrier amplitude, phase, and frequency modulations, and a single-sideband form of frequency modulation. Signal processing techniques of preemphasis, companding, and time assignment speech interpolation bandwidth. Expressions are developed for the message waveform–resultant rf waveform relationship, the corresponding relationships between Fourier spectra, the rf peak-to-average power ratio and band width, and multi-channel basebands formed by the frequency-division multiplexing employing single-sideband modulated subcarriers. General relationships between input and output signal-to-noise ratios are derived for superheterodyne receivers employing product, envelope, phase, and frequency demodulators. N.E.N.

N67-18548*# Ohio State Univ., Columbus. Electroscience Lab.
CONSTITUTIVE PARAMETER MEASUREMENTS USING THE SCATTERING TECHNIQUE
Jonathan D. Young 6 Feb. 1967 32 p refs
(Contract NSR-36-008-027)
(NASA-CR-82015; TR-1903-4) CFSTI: HC $3.00/MF $0.65 CSCL 20N

A system has been constructed in order to evaluate the practicability of the scattering technique for measuring the constitutive parameters, μ and ϵ, of materials. Measurement data have been obtained for samples having a wide range of parameter values. Experimental results and a system error analysis are used to predict feasible accuracy for this technique. Author

N67-18649# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ON THE IMPEDANCE OF A SATELLITE BORNE VLF ELECTRIC FIELD ANTENNA
T. L. Aggson and C. A. Kapetanakos Aug. 1966 47 p refs
(NASA-TM-X-55668; X-612-66-380) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The source impedance of a satellite borne VLF antenna is calculated using probe theory. Numerical examples of the impedance are given for typical plasma parameters for a short cylindrical antenna. It is shown that at these frequencies the resistive component dominates the imaginary component along with ionospheric and magnetospheric satellite orbits. This result is used to re-examine the interpretation in terms of electrostatic waves to explain the VLF noise observed by the satellite 1964–45A. It is shown that if a VLF antenna is monitored with a charge sensitive amplifier, the output signal is proportional to the product of the ambient signal level and the plasma density. The sustained noise enhancements observed on the 1964–45A satellite are thus attributed to changes in the antenna impedance along the satellite orbit rather than from changes in the ambient plasma noise level. Author

N67-18654*# Space-General Corp., El Monte, Calif.
STUDY OF CONCEPTUAL DEEP SPACE MONITOR COMMUNICATIONS SYSTEMS USING A SINGLE EARTH SATELLITE. VOLUME III: APPENDIX
E. F. Lally and M. Elmer Sep. 1966 316 p refs
(Contract NAS2-3179)
(NASA-CR-76036; SGC-920FR-1, Vol. III) CFSTI: HC $3.00/MF $0.65 CSCL 17B

Condensed technological survey materials for deep space satellite communication systems are presented in this appendix to the main study. Emphasis was placed on mission analysis, satellite discipline parametric requirements, and design interface considerations for communication, power, attitude control, and environmental control. G.G.

N67-18698*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
EXPERIMENTAL MEASUREMENTS OF THE SHORT BACKFIRE ANTENNA
L. R. Dod Oct. 1966 44 p refs
(NASA-TM-X-55680; X-525-66-480) CFSTI: HC $3.00/MF $0.65 CSCL 09F

Experimental radiation patterns and gain have been measured for the short backfire antenna as a function of the antenna dimensions. The antenna consists of two planar reflectors of different diameters separated by one-half wavelength forming a leaky cavity resonator with radiation normal to the smaller reflector. The antenna is fed by a dipole at the midpoint between the two reflectors and yields useful gains of 10 to 15 db. Typical values for the reflector diameters are 2.0 and 0.5 wavelengths. The addition of a quarter-wave rim on the large reflector reduced back radiation from 20 to below 30 db. The frequency bandwidth of the antenna is presently limited by the impedance match obtainable at the antenna input. Author

N67-18729*# Melpar Inc., Falls Church, Va.
THIN-FILM PERSONAL COMMUNICATIONS AND TELEMETRY SYSTEM: (TFPCTS). PHASE II Quarterly Report, Sep. 24–Dec. 24, 1966
Jan. 1967 32 p
(Contract NAS9-3924)
(NASA-CR-65591; QR-3) CFSTI: HC $3.00/MF $0.65 CSCL 09F

Development work is continuing on the thin-film transistors. We were able to use the transistors in the source followers in the "Summing Resistor Network" module and we will continue to evaluate the transistors for use in other modules. The RF tuning procedure is difficult because the interstage capacitor networks determine both the impedance match and the frequency of operation. The thin-film capacitors must be deposited with close tolerance to the design values because trimming methods for capacitors introduce parasitic inductance or resistance. Further design effort will be required to find a suitable RF trimming procedures. Author

N67-18740*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
EVALUATION OF RANGE ACCURACY FOR THE GODDARD RANGE AND RANGE RATE SYSTEM AT ROSMAN
John H. Barbert, Robert Reigh (RCA Ser. Co.), and J. Stephenson (Brown (D.) Assoc.) Oct. 1966 24 p refs
(NASA-TM-X-55687; X-514-66-513) CFSTI: HC $3.00/MF $0.65 CSCL 09F

This report presents the evaluation of the range accuracy of the GRARR Tracking System at Rosman, North Carolina, when compared with the SECOR system. Sample range data were obtained from the Rosman and the SECOR stations. The GEOS Data Adjustment Program (GDAP) is used to determine the values of state variables which affect the range accuracy. Credence of the state variables is given, and then the data are summarized and analyzed. Conclusions and recommendations for future operation are then made. Author

N67-18748*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE EFFECT OF DIGITIZING NOISE ON SPECTRAL SIGNAL TO NOISE RATIOS IN FOURIER SPECTROSCOPY
Michael L. Forman Sep. 1966 20 p refs
(NASA-TM-X-55679; X-622-66-478) CFSTI: HC $3.00/MF $0.65 CSCL 09F

A discussion of digitizing noise and its effect on spectral signal to noise ratios subject to the limitations of the telemetry system forms the main body of this study. Simulated and actual test data are compared with the theoretical calculations and an optimum working code is derived. The code used in the Nimbus B infrared interferometer spectrometer is found to be very close to the optimum condition for the number of bits used per data word. Author

N67-18749*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A COMPLEMENTARY SLOT-DIPOLE ANTENNA FOR HEMISPHERICAL COVERAGE
W. F. Gabriel and L. R. Dod Oct. 1966 45 p refs
(NASA-TM-X-55681; X-525-66-485) CFSTI: HC $3.00/MF $0.65 CSCL 09F

A circularly polarized, complementary slot-dipole antenna with hemispherical coverage has been developed for use in a passive interferometer beacon acquisition system. The antenna element consists of a crossed-slot flush mounted in the ground plane, plus a crossed dipole mounted about 0.58 λ above the crossed-slot with axes aligned. The crossed-dipole is fed from below by means of a circularly polarized waveguide, and the crossed-dipole is fed from a balanced four-wire transmission line which is electrically connected in shunt across the slots. Approximately equal radiated power division is achieved between the crossed-slots and the crossed dipoles which, together with the complementary pattern characteristics of the slot and the dipole, results in a good circular polarization characteristic over most of the hemisphere and permits a reasonably effective approximation to a cosecant-squared power pattern characteristic coverage in elevation except near the horizon. Final design and performance data on the antenna are included. During the development of this antenna element, several other elevation pattern shaping techniques were investigated and are discussed. These include surface-wave devices, ground plane chokes, and vertical arrays. Author

N67-18762*# Stanford Research Inst., Menlo Park, Calif.
THE EFFECTS OF A PLASMA IN THE NEAR-ZONE FIELD OF AN ANTENNA Final Report
W. C. Taylor and D. E. Weissman Jun. 1964 40 p refs
(Contract NAS1-3099; SRI Proj. 4555)
(NASA-CR-66298) CFSTI: HC $3.00/MF $0.65 CSCL 20N

The problem of radiating energy from an antenna immersed in a finite plasma, under various conditions of the ratios of the collision frequency and the plasma frequency to the Radian Frequency is studied. This has been done by focusing attention on the two basic types of radiators—the tors—the small dipole and loop—and observing their properties theoretically and experimentally in a dissipative medium similar to that present on a reentry vehicle. Consideration has also been given to the impedance-matching problem with small antennas and also to the effects of sheaths surrounding the antenna surface. Author

N67-18770*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
DUAL FREQUENCY (20.0–19.9 kHz) VLF DATA
Chesley H. Looney, Jr. Jan. 1967 23 p refs
(NASA-TM-X-55702; X-520-67-35) CFSTI: HC $3.00/MF $0.65 CSCL 09F

Data are presented for a twelve-month operation of a radio station transmitting 20.0 kHz and 19.9 kHz. The 20.0 kHz signal is controlled so that a particular positively sloped zero crossing is always synchronous with the master to within 1.0 microsecond. The 19.9 kHz transmission is also controlled so that a particular positively sloped zero crossing is synchronous with a particular positively sloped zero crossing of the 20.0 kHz transmission to within 1.0 microsecond. Daily measurements of these transmissions can be used to remove certain systematic variations so that the 19.9 kHz and 20.0 kHz differential phase angle as transmitted can be known to less than 0.2 microsecond. Tabulations are presented for daily measurements of the corrected signal phase angles. The 20.0/19.9 kHz data is a function of the phase angle of the 100 Hz information inherent in the 20.0/19.9 transmissions. This data can be used to resolve the 50 microsecond ambiguity inherent in 20.0 kHz single frequency transmissions. Included in the figures is a plot of vlf noise versus solar activity, with each type of data averaged quarterly indicating the correlation between solar activity and vlf noise. S.P.

N67-18950*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AN ANALYSIS OF A FIRST-ORDER POLYNOMIAL PREDICTOR FOR DATA COMPRESSION
M. Melvin Bruce (M.S. Thesis—Virginia Univ.) Washington, NASA, Mar. 1967 30 p refs
(NASA-TN-D-3866) CFSTI: HC $3.00/MF $0.65 CSCL 09D

A theoretical analysis is presented of a first-order polynomial predictor for use in data compression. The investigation is concerned with compressing data which existed in the form of samples taken at a constant rate. This analysis is also limited to data having a Gaussian distribution of amplitude. Four pseudo-random time histories with different amplitude spectra are compared by using this method. A digital computer was used to generate data approximating the four time histories and to measure the compression possible in the generated data for comparison with the theoretical calculations. The results of this investigation show that, under known conditions, it is possible to calculate the amount of data compression which can be obtained through the use of a first-order polynomial predictor. This investigation also shows that high frequencies in the data reduce the amount of compression and that there is a trade-off between the amount of error introduced by the compression system and the amount of compression obtained. This method of analysis is limited to data with known statistics. Author

N67-18974*# Kansas State Univ., Manhattan. Dept. of Electrical Engineering.
POLARIZATION DEPENDENT RADAR RETURN FROM ROUGH SURFACES
Kumar Krishen, W. W. Koepsel, and S. H. Durrani Jan. 1968 69 p refs
(Contract NSR-17-004-003; Grant NsG-692)
(NASA-CR-82401; EE-TR-2) CFSTI: HC $3.00/MF $0.65 CSCL 17I

For the radar exploration of the surface properties of a target, such as the Moon, a cross-polarization technique is developed. Assuming a Gaussian distribution for the surface slopes, an expression is derived in case of a layer with random thickness which shows that the depolarization factor depends on the dielectric properties of the medium, the slope structure of the rough interface, the wave length and the angle of incidence. Due to the complexity of this expression emphasis was placed on the experimental observations. The experimental investigations were conducted on a target model with Gaussian surface structure. The following results were obtained: (1) graphs of $\langle D \rangle$ versus θ_2 for targets with identical statistics but different dielectric constants, (2) graphs of $\langle D \rangle$ versus ϵ, with layer statistics as a parameter (these were drawn after averaging $\langle D \rangle$ over θ_2), and (3) the dependence of

<D> on θ_1 and range. The experimental results indicate that for a particular type of the target statistics cross-polarization factor can be used to identify the dielectric constant of the surface of reflection. Author

N67-18991*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
APOLLO SYSTEMS
Jun. 1966 30 p
(NASA-TM-X-55707; X-550-66-282) CFSTI: HC $3.00/MF $0.65
CSCL 09F

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N67-18992*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
APOLLO NETWORK
Carl O. Roberts, Jr. *In its* Apollo Systems Jun. 1966 p 1–2 (See N67-18991 08-07) CFSTI: HC $3.00/MF $0.65

The network data systems required for processing and displaying large amounts of information in support of the Apollo project are discussed. The unified S-band system, stored program Pulse Code Modulation (PCM) telemetry decommutators, computer-driven alpha numeric displays, and a general purpose data processing system utilizing 642 modified computers are briefly described. Other data systems mentioned include TV monitors, scan converters, high speed printers, stored program PCM simulators, VHF predetection diversity combining receivers, and wide band receivers. It is emphasized that maximum flexibility, through modularity of design, and high reliability, through selected redundancy and use of solid state circuitry, were considered as important factors in the design of the network equipment. A.G.O.

N67-18993*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
UNIFIED S-BAND SYSTEM
W. Paul Varson *In its* Apollo System Jun. 1966 p 3–5 (See N67-18991 08-07) CFSTI: HC $3.00/MF $0.65

The unified S-band (USB) system is incorporated into the Apollo network to provide tracking and communications capabilities to lunar distances. The design of the USB system is based on a coherent Doppler and pseudorandom range system which utilizes a single carrier frequency in each direction for the transmission of all tracking and communications data between the spacecraft and ground. Ability to provide data for two spacecraft simultaneously, provided they are within the beamwidth of the single antenna, is supplied by this system. Tracking and communications with the spacecraft during the lunar missions will be provided by three primary deep-space facilities, employing 85-foot antennas. Four land stations and one instrumentation ship are also required to provide continuous USB coverage from launch through insertion. A.G.O.

N67-18995*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
APOLLO DISPLAY SYSTEM
Keith D. Fellerman *In its* Apollo System Jun. 1966 p 11–13 (See N67-18991 08-07) CFSTI: HC $3.00/MF $0.65

The display system serves as an interface between flight controllers and the high speed data processing equipment such as the telemetry and command computers and the PCM data handling equipment. This system permits the display of printed information and charts of real time data on a Cathode Ray Tube (CRT). The displays are unique in that there is the ability to write on any part of the CRT with direct access to the particular X and Y coordinates that the character or vector are to appear at, rather than a sweeping of the entire tube. In addition to the CRT displays the system consoles have event displays which are lamps driven by either the PCM stations or the computers via the Console Computer Interface Adapter (CCIA). A.G.O.

N67-18996*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
CCIA-DATA CALL-UP SYSTEM FOR APOLLO
Charles E. Trevathan *In its* Apollo System Jun. 1966 p 15–16 (See N67-18991 08-07) CFSTI: HC $3.00/MF $0.65

The Console Computer Interface Adapter (CCIA) provides the means of communication between the seven flight control consoles and the telemetry and command computers of the Apollo data processor system. Contained in the CCIA subsystem are two Univac 1218 computers and a Multiplexer (MUX), which is composed of two identical sections. One section will service four consoles and the second section will service three consoles. This dual configuration yields a CCIA that can tolerate any "worst case" failure and continue mission support with at least half the flight controllers display hardware and keyboards operational. A.G.O.

N67-18997*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
APOLLO PCM DECOMMUTATION SYSTEM
William A. Dentel *In its* Apollo System Jun. 1966 p 17–18 (See N67-18991 08-07) CFSTI: HC $3.00/MF $0.65

The PCM decommutation system reconstructs incoming serial data, obtains synchronization with the spacecraft's commutation equipment, and distributes selected data for measurements to the proper output for further processing or display. Incoming data is processed in one of the system's two signal conditioners whose function is to obtain bit synchronization, make a bit by bit decision on the incoming data in the presence of signal perturbations such as noise and jitter, and then reconstruct the data in the form required by the decommutator. The decommutator receives this reconstructed data and begins a searching process to obtain synchronization with the incoming data. Data is further processed for various output devices. The system has the capability to perform diagnostic self test routines for the purpose of maintaining the equipment. A.G.O.

N67-18998*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
APOLLO DIGITAL COMMAND SYSTEM
Carl B. Knox *In its* Apollo System Jun. 1966 p 19–21 (See N67-18991 08-07) CFSTI: HC $3.00/MF $0.65

The Apollo Digital Command System (DCS) provides a means of communicating with and controlling the spacecraft's equipment from the ground. Some commands are identified before

the launch, while others are developed by the computing complex at the mission control center (MCC). Commands are generated at the MCC and then transmitted to the Manned Spaceflight Network (MSFN) stations around the world for retransmission to the spacecraft. There will be two general operational modes of the command system depending on the site configuration: (1) those used at sites with flight controllers, and (2) those used at sites without flight controllers or consoles. Commands will be sent to the spacecraft via one of two links, the USB equipment at 2106.4 or 2108.8 Mc, or the uhf equipment at 408 to 450 Mc. A constant check on the effectiveness of the ground equipment is maintained by sampling the rf signal with verification receivers located near the transmitters. A.G.O.

N67-19000*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
MANNED SPACE FLIGHT NETWORK TESTING FOR APOLLO
Carl O. Roberts, Jr. *In its* Apollo System Jun. 1966 p 27–29
(See N67-18991 08-07) CFSTI: HC $3.00/MF $0.65

Test plans for the checkout and qualification of data systems installed in the Apollo network are described. This engineering test program is divided into the following categories: (1) factory unit test, (2) on-site unit test, (3) special test, (4) systems integration test, and (5) dynamic integration test. Tests are designed to progress from the lowest building block to the demonstration of over-all site performance. Special network tests include a site acceptability evaluation program and a site operational program test. A.G.O.

N67-19044*# Illinois Univ., Urbana. Antenna Lab.
ANTENNA INPEDANCE IN A WARM PLASMA
J. W. Carlin and R. Mittra Dec. 1966 110 p refs Antenna Lab. Rept.-66-18
(Grant NsG-395)
(NASA-CR-82373; SR-9) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Expressions are derived for the impedance of biconical and cylindrical dipoles in a warm isotropic plasma. A linearized hydrodynamic description was used as a plasma model. In determining the impedance of a cylindrical dipole in intimate contact with a plasma, the effect of the induced acoustic sources (force and fluid flux distributions) on the antenna surface were accounted for in addition to the effects of the induced current distribution. In general, the effect of the acoustic sources on impedance was found to be small. In the treatment of a biconical dipole the antenna was assumed to be encased in an insulating dielectric immersed in a plasma. An exact expression was derived for the terminal admittance for very thin antennas. Compressibility effects seemed to be quite significant when the acoustical phase length of the antenna was approximately 20 or less. The presence of an ion sheath decreased the power radiated in the plasma wave. Results show that plasma waves cause quite a marked change in antenna impedance. Induced acoustic sources, on the other hand, appear to have little effect on the impedance of a cylindrical dipole. S.P.

N67-19054*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
TROPOSPHERIC AND IONOSPHERIC EFFECTS UPON RADIO FREQUENCY (VHF–SHF) COMMUNICATION
E. Hirschmann Jan. 1967 28 p refs
(NASA-TM-X-55709; X-731-67-89) CFSTI: HC $3.00/MF $0.65 CSCL 17B

A realistic estimate of the tropospheric and ionospheric influence upon the range and range-rate measurements. In connection with the location and communication with aircraft by satellite transponder project it was necessary to provide a basis for selecting a suitable operating frequency where the range and range-rate errors introduced by the atmosphere will allow precise determination of the location of high-speed aircraft by means of a synchronous altitude satellite. Author

N67-19098*# Ohio State Univ., Columbus. ElectroScience Lab.
NOTES ON DIGITAL SPECTRAL ANALYSIS
Richard Turpin 6 Feb. 1967 35 p refs
(Grant NsG-213)
(NASA-CR-82488; Rept.-1388-23) CFSTI: $3.00 CSCL 09D

Included are discussions of smoothing and decimation, lag and spectral window, Fourier transform methods, autocovariance, and power spectral density, all with emphasis on application to sampled data or to discrete functions. The interrelations between various parameters are discussed, including the bandwidth of the spectrum of interest, system bandwidth requirements, spectral resolution and stability, the amount of data needed, and the sampling rate. Author

N67-19117* Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
SUMMARY OF RESEARCH Semiannual Status Report, 1 May–31 Oct. 1966
Robert G. Gallager 21 Feb. 1967 6 p refs
(Grant NsG-334)
(NASA-CR-82661) CFSTI: $3.00 CSCL 09D

Research focusing on the development of space communication techniques is reported. Data are presented in the following areas: convolutional codes and decoding, optical communication, specific channels and coding, source coding with a distortion measure, and coding and the processing of information. A technique was investigated for combining block coding with convolutional coding. By using a combination of sequential decoding and algebraic coding, it has been demonstrated that reliable communication can be achieved at all rates below channel capacity. The extension of communication theory to optical channels has focused upon the effects of atmospheric turbulence. A model that is appropriate for the analysis of communication systems was developed using the techniques of geometric optics. A number of coding theorems were developed for statistically related parallel channels in the absence of cross talk. A theoretical study of the use of coding on unsynchronized, noisy channels is in progress. The interrelations between source and channel coding were studied for discrete memoryless sources and channels. Results indicate that for combined source and channel coding with block length n, the dependence of the rate of approach with n being between $1/n$ and $1n\ n/n$. Techniques for reducing the probability of error during the coding and processing of information are cited. S.C.W.

N67-19135*# ADCOM, Inc., Cambridge, Mass.
INTERMODULATION DISTORTION FROM RECEIVER NON-LINEAR PHASE CHARACTERISTICS Final Report
Ahmad F. Ghais, Charles J. Boardman, and Bert D. Nelin 2 Dec. 1966 135 p refs
(Contract NAS5-9742)
(NASA-CR-82444) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The effect of predetection-filter characteristics on telemetry-data quality is studied. Intermodulation distortion is recognized as the primary data-degrading effect. A realistic, practical and tractable method of characterizing this type of distortion is shown to be the noise-loading technique. Mathematical models are formulated for angle-modulation systems, and distortion mechanisms are identified. In the quasi-stationary case, the distortion is determined entirely by the filter phase characteristic, whereas in the general case the whole transfer function determines the distortion. The preceding results are applied to the computation of

intermodulation distortion levels produced by predetection filters in telemetry systems. Filter types commonly employed in telemetry receivers are catalogued along with their distortion levels, shape factors and noise bandwidths. The noise-loading technique is also applied to the characterization of nonlinearities in modulators and demodulators. Author

N67-19139*# Michigan Univ., Ann Arbor. Radiation Lab.
STUDY OF PLASMA SHEATH ASSOCIATED WITH COMMUNICATIONS BLACKOUT Final Report, Jun. 1963–Dec. 1966
Andrejs Olte 31 Dec. 1966 3 p refs /ts Tech. Rept.-5825-10-T
(Grant NsG-472)
(NASA-CR-66280) CFSTI: HC $3.00/MF $0.65 CSCL 20N

This bibliography lists all technical reports issued in connection with the study of plasma sheath association in communications blackout. Work covered the following re-entry connected phenomena: (1) Radiation of a unit electric line source through a concentric axially slotted plasma sheath; (2) radiation of a magnetic line source excited cylinder through a slotted plasma sheath; (3) terminal admittance of a wedge guide that excites a perfectly conducting cylinder which is enclosed by a slotted shell and a plasma sheath; and (4) the importance of electrokinetic waves on the antenna surface current distribution. G.G.

N67-19147 General Electric Co., Syracuse, N. Y. Electronics Lab.
OPTIMIZATION AND SYNTHESIS OF ANTENNA ARRAYS Final Report, Mar. 1964–Jun. 1966
S. L. Shih Jul. 1966 103 p refs
(Contract AF 19(628)-3842)
(AFCRL-66-525; AD-638034) CFSTI: HC $3.00/MF $0.65

New methods are developed for the optimization and synthesis of antenna arrays. The first part deals with the problem of optimizing the performance of an array in terms of gain, supergain ratio, and sidelobe. For the optimization of the gain, it is proposed to adjust both the excitation and the spacing of the elements. The determination of the optimum excitation, spacing and gain is shown to be an eigenvalue problem and is carried out on a digital computer using the difference calculus and the Newton–Raphson method. For the minimization of the supergain ratio, it is shown that this can also be reduced to an eigenvalue problem. For the reduction of the sidelobes, a new method is developed by which the phase shifts of the elements required for the minimum sidelobe level are determined in one step. In the synthesis part, orthogonal functions including the sinc function, ultraspherical polynomials, Chebyshev polynomials and Legendre polynomials are used to synthesize an array to radiate a prescribed pattern. Another new synthesis method is developed using the lambda function which is not an orthogonal set. The synthesized array approximates the prescribed pattern with a high degree of precision. Finally, the equivalence between linear and planar arrays is established which enables the extension of the previous work in two-dimensional arrays, in particular, the planar arrays with shaped contour. Author (TAB)

N67-19181*# Atlantic Research Corp., Alexandria, Va. Jansky and Bailey Systems Engineering Dept.
TECHNICAL AND COST FACTORS THAT EFFECT TELEVISION RECEPTION FROM A SYNCHRONOUS SATELLITE Final Report
30 Jun. 1966 196 p refs
(Contract NASw-1305)
(NASA-CR-76601; TR-PL-9037) CFSTI: HC $3.00/MF $0.65 CSCL 17B

Technical requirements for providing television video of defined grades of quality are specified. All combinations of equipment that provide satisfactory reception are considered. A large range of different values of Effective Radiated Power (ERP) are assumed and a specific determination is made of minimum cost receiving systems parameters for each assumed value of satellite ERP. A separate set of solutions is derived for operation in different parts of the frequency spectrum from 200 Mc/s to 12,000 Mc/s. The results include combinations of receiving station's parameters that range from low cost to expensive receiving installations. Cost and performance information for components which can be provided between now and 1970 provided a requirement is established is given. A computer program using the IBM 360-30 system was used to facilitate determination of a minimum cost receiving system from all possible combinations of receiving system parameters. The rationale used in optimization of system parameters for various values of assumed satellite power and for operation in different parts of the spectrum is explained. L.S.

N67-19182 Deutsche Forschungsanstalt fur Luft- und Raumfahrt, Brunswick (West Germany). Institut fuer Flugfuehrung.
TELEMETRY GROUND STATIONS IN THE FEDERAL REPUBLIC OF GERMANY [TELEMETRIEBODENSTATIONEN IN DER BUNDESREPUBLIK DEUTSCHLAND]
W. D. Kabiersch Aug. 1966 29 p In GERMAN; ENGLISH Summary
(DLR-Mitt.-66-17) CFSTI: $3.00

The telemetry ground stations in the Federal Republic of Germany are listed. Their technical equipment and their projected enlargement are briefly described. The block-diagrams of some stations are added. Author

N67-19188 Radio and Space Research Station, Slough (England).
KINETHEODOLITE OBSERVATIONS OF SATELLITES RECEIVED BY THE SATELLITE ORBITS GROUP FROM MALTA FOR MAY 1966
1966 45 p /ts Issue No. 20, Pt. 1
CFSTI: $3.00

Tables of Cinetheodolite observations from Malta made during May 1966 of Echo 1 (1960-09A), Echo 1 Rocket (1960-09B), Samos 2 (1961-01A), Ariel 1 Satellite (1962-15A), Ariel 1 Rocket (1962-15B), Star-rad (1962-58A), Midas 7 (1963-30A), Dash 2 (1963-30D), Echo 2 Rocket (1964-04B), Cosmos 44 Satellite (1964-53A), Cosmos 44 Rocket (1964-53B), Cosmos 55 Satellite (1965-11B), Cosmos 54 Rocket (1965-11D), Snapshot (1965-27A), and Pegasus 2 (1965-39A). The data consist of times, azimuths, and elevations. L.S.

N67-19206* Harvard Univ., Cambridge, Mass. Gordon McKay Lab.
THEORETICAL AND EXPERIMENTAL INVESTIGATIONS OF ANTENNAS AND WAVES IN PLASMA Semiannual Status Report, Sep. 1, 1966–Feb. 28, 1967
Ronold W. P. King 1 Mar. 1967 12 p refs
(Grant NGR-22-007-056)
(NASA-CR-82529) CFSTI: HC $3.00 CSCL 20N

Brief summaries of progress being made on a number of studies concerned with antennas and waves in plasma are presented. These include theoretical and experimental studies of finite cylindrical antennas in a plasma column, plasma coated antennas, a plasma sheath using a microwave cavity technique, transmission lines in plasma, brush-cathode discharges, acoustic effects in plasma, an antenna immersed in a plasma, and coupled monopoles in a plasma. R.N.A.

N67-19225# Norwegian Defence Research Establishment, Kjeller.
LONG RANGE PROPAGATION STUDIES Final Scientific Report, 15 Sep. 1964–30 Jun. 1966

Kristen Folkested Sep. 1966 32 p refs
(Contract AF 61(052)-835)
(E-91; AFCRL-66-841; AD-644638) CFSTI: HC $3.00/MF $0.65

The report describes activity associated with step frequency oblique soundings in northern Norway. Pertinent operational parameters are given. Various representative samples of backscatter recordings, together with appropriate deductions are displayed. Results from comparing measured data with the outcome of theoretical computations are dealt with in one of the chapters. A brief description of two general ray-tracing methods, with worked examples, has been inserted. Some aspects of fading are treated. Experimental findings related to HF-communication are summarized. Author (TAB)

N67-19234# Naval Aid Development Center, Johnsville, Pa. Aero-Electronic Technology Dept.
CLUTTER MODEL FOR AEW RADAR DESIGN
J. A. Di Toro 29 Nov. 1966 64 p refs
(NADC-AE-6638; AD-644567) CFSTI: HC $3.00/MF $0.65

The report provides a clutter model based on currently available data, and is intended to be used in the design and evaluation of AEW radar techniques. It presents expected values of clutter amplitude as related to antenna depression angle, radio frequency, and polarization of the transmitting and receiving antennas. It also indicates typical doppler spectra. Author (TAB)

N67-19236# Rome Air Development Center, Griffiss AFB, N. Y.
DESIGN AND EVALUATION OF TWO-REFLECTOR ANTENNA SYSTEMS Final Technical Report
Donald A. Hildebrand Nov. 1966 69 p refs
(RADC-TR-66-582; AD-644107) CFSTI: HC $3.00/MF $0.65

The report presents the major aspects of the design of certain two-reflector antenna systems which might be employed as fractional-degree beam low-noise detection and tracking antennas. The influences of various parameters on performance are discussed, and a computer program for use in designing and evaluating such systems is presented. The program is written in the FORTRAN language and is highly efficient. An operating manual is included. The program can be used by anyone with a cursory knowledge of FORTRAN and format specifications. Author (TAB)

N67-19329# Rome Air Development Center, Griffiss AFB, N. Y. Research and Technology Div.
ADAPTIVE DECOMPOSITION OF SUPERPOSITIONS OF PROBABILITY DENSITY FUNCTIONS
John D. Sammon, Jr. (Ph.D. Thesis—Syracuse Univ.) Nov. 1966 78 p refs
(RADC-TR-66-540; AD-644161) CFSTI: HC $3.00/MF $0.65

A method of approximating an ultradistribution is given in conjunction with the adaptive solution technique. An algorithm is developed for solving the multidimensional problem by first solving p+1 one-dimensional problems where p is the dimension of the sample vectors. Finally, a computer simulation of the adaptive technique was conducted on a sample problem where the elements of the mixture were selected as Gaussian. The results of this experiment are reported. TAB

N67-19337# Advisory Group for Aerospace Research and Development, Paris (France).
SELECTED AIRCRAFT INTEGRATED DATA SYSTEMS PAPERS FROM AGARD FLIGHT MECHANICS PANEL–TWENTY-SIXTH MEETING
Jun. 1965 61 p Presented at the 26th Meeting of the Flight Mech. Panel, Paris, Jun. 1965
(AGARD-508) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. FLIGHT TEST APPLICATION OF AN INTEGRATED AIRCRAFT PCM DATA SYSTEM R. J. Grissman (Air Force Flight Test Center) p 1–17 (See N67-19338 08-07)

2. INTEGRATED AIRCRAFT PCM DATA SYSTEM FOR THE C-141 AIRCRAFT L. D. Huppert (Garrett Corp) p 19–57 (See N67-19339 08-07)

N67-19338# Air Force Flight Test Center, Edwards AFB, Calif.
FLIGHT TEST APPLICATION OF AN INTEGRATED AIRCRAFT PCM DATA SYSTEM
R. J. Grissman *In* AGARD Selected Aircraft Integrated Data Systems Papers from AGARD Flight Mech. Panel Jun. 1965 p 1–17 (See N67-19338 08-07) CFSTI: HC $3.00/MF $0.65

Prior to aircraft entry into the United States operational inventory, the entire aircraft system is subjected to an intensive evaluation at the Air Force Flight Test Center (AFFTC). This paper is concerned with the techniques and methods used to perform the aircraft subsystems analysis portion of this evaluation. The AFFTC has procured a totally automated data system, from acquisition to printout, and the criteria used in selection of the instrumentation equipment and of the parameters chosen are discussed. Some definitive reasons for establishing the various criteria are described and some parameter selection errors of oversight are noted. Techniques used at the AFFTC to convert and apply the gathered data are explained and related to previously utilized partially automated data systems. Present uses and possible long-range benefits to aircraft subsystems testing and design philosophy resulting from this new methodology are also considered. Author

N67-19339# Garrett Corp., Los Angeles, Calif. AiResearch Manufacturing Div.
INTEGRATED AIRCRAFT PCM DATA SYSTEM FOR THE C-141 AIRCRAFT
L. D. Huppert *In* AGARD Selected Aircraft Integrated Data Systems Papers from AGARD Flight Mech. Panel Jun. 1965 p 19–57 (See N67-19338 08-07) CFSTI: HC $3.00/MF $0.65

This paper deals with the hardware of the Integrated Aircraft Data System (IADS). The hardware consists of existing aircraft transducers, additional supplementary transducers, a signal preconditioner unit, a signal data translator, a digital recorder, a control panel, and a time generator and display unit. The IADS system monitors 196 parametric inputs (plus 27 spares), which are sampled at rates varying from once per second to once per sixteen seconds. System accuracy (excluding transducers) is ±1% of reading or ±0.5% of full scale, whichever is greater under the expected flight environment. Thirty hours of data can be recorded before replacement of the quick change tape magazine is necessary. The flight tapes can be quickly, accurately, and automatically processed in the existing AFFTC computer facilities without the need for special ground playback equipment. Future system expansion potential to encompass the functions of maintenance recording, on-board maintenance analysis, crash recording, and PCM telemetry is also discussed. Author

08 COMPUTERS

Includes computer operation and programming; and data processing. For basic research see: 19 Mathematics.

N67-18339*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
A DATA REDUCTION TECHNIQUE FOR DISTRIBUTION ANALYSIS
A. B. Whitehead, R. H. Parker, and E. L. Haines *In its* Space Programs Sum. No. 37-42, Vol. IV 31 Dec. 1966 p 167–170 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

As memory capacity may be limited in many applications, an alternative approach is described in which the measurements of a physical quantity are raised to various powers that are accumulated in a few summing registers. The number of registers required are no greater than the number of independent quantities sought from the experiment. From the summed powers of the measurements, the moments of the analysis of the equivalent histogram may be determined, or the function that describes the statistically meaningful part of this distribution may be generated. The data collection procedure is discussed, along with the problems involved in extracting the most meaningful information from the sums retrieved. Two approaches for minimizing these problems are suggested: choosing a different functional form for the distribution; and adjusting the parameters of the initially computed function until the function, multiplied by the appropriate power of the variable and integrated over the known definite interval, equals the corresponding measured sum. M.G.J.

N67-18350*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
INFORMATION PROCESSING: ARITHMETIC DECODING OF CYCLIC CODES
G. Solomon *In its* Space Programs Sum. No. 37-42, Vol. IV 31 Dec. 1966 p 205–208 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

A simplified arithmetic decoding procedure is presented for the $(2^k-1,k)$ maximal length shift register codes, and for the cyclic versions of the second-order Reed–Muller $(2^k-1,\ 1+k+(k/2))$ codes. The procedure requires only a fixed permutation, vector addition, and weight counting. It takes k steps in the maximal length case, and mk steps in the Reed–Muller cases where m is the number of information bits. The algorithm is independent of the number of errors. This is considered an improvement in the state of the art for low rate codes with high error correction ability. Author

N67-18351*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
DATA COMPRESSION TECHNIQUES: RECENT RESULTS ON EPSILON ENTROPY
E. C. Posner, E. R. Rodemich, and Howard Rumsey, Jr. *In its* Space Programs Sum. No. 37-42, Vol. IV 31 Dec. 1966 p 208–213 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

The concept of epsilon–delta entropy is introduced for objects called probabilistic metric spaces; this space is a probability space and also a metric space in which every open set is measurable. The epsilon–delta entropy of a probabilistic metric space is defined for arbitrary positive epsilon and nonnegative delta as the infimum of the entropies of all epsilon–delta partitions of the space. The concept is applied to data compression techniques, with consideration given to the class of examples of probabilistic metric spaces obtained from mean-continuous stochastic processes on the unit interval. A condition on the eigenvalues of the process is given so that any process satisfying that condition has finite epsilon entropy for any epsilon greater than zero. For any set of eigenvalues not satisfying the given condition, a mean-continuous process on the unit interval having infinite epsilon entropy for every epsilon greater than zero is introduced. M.G.J.

N67-18399*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COMPUTER PROGRAM FOR DESIGN-POINT PERFORMANCE OF TURBOJET AND TURBOFAN ENGINE CYCLES
Michael R. Vanco Washington, NASA, Feb. 1967 43 p refs
(NASA-TM-X-1340) CFSTI: HC $3.00/MF $0.65 CSCL 21E

The Fortran 7094 computer program for the calculation of the design-point performance of turbojet and turbofan engine cycles is presented along with the thermodynamic equations used. This program requires as input the airplane Mach number, the altitude-state conditions, turbine-inlet temperature, afterburner temperature, duct-burner temperature, bypass ratio, coolant flow, component efficiencies, and component pressure ratios. The output yields specific thrust, specific fuel consumption, engine efficiency, and several component temperatures and pressures. The thermodynamic properties of the gas are expressed as functions of temperature and fuel to air ratio. Sample input and output are included for an example case. Author

N67-18447# Syracuse Univ. Research Inst., N. Y.
THEORY OF ADAPTIVE MECHANISMS Final Report, Jun. 1963–Jun. 1966
M. K. Hu, E. P. Stabler, L. F. Chang, W. S. Bennett, Jr., and R. Herman et al Griffiss AFB, N. Y., RADC, Nov. 1966 149 p refs
(Contract AF 30(602)-3197)
(RADC-TR-66-510; AD-643691) CFSTI: HC $3.00/MF $0.65

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N67-18449# Syracuse Univ. Research Inst., N. Y.
A STATISTICAL STUDY OF THE VARIATIONS OF MOMENT INVARIANTS, PART 3
R. Herman *In its* Theory of Adaptive Mech. Nov. 1966 p 22–68 refs (See N67-18447 08-08) CFSTI: HC $3.00/MF $0.65

Pattern recognition by means of the moment inveriant method is theoretically capable of identifying patterns under translation, isotropic magnification and rotation. Implementation of this scheme on a computer yields results that indicate that a classification scheme is feasible. A statistical analysis of the individual invariants for the various patterns tested seems to indicate that the scheme may be applied to a larger class of patterns. Included is a discussion of the quantizing and bias problems that occur when implementing this method. A theoretical investigation shows the cause of many of these problems and indicates the types of patterns most subject to them. Author

N67-18450# Syracuse Univ. Research Inst., N. Y.
ITERATIVE ARRAYS OF IDENTICAL LOGIC CELLS, PART 4
V. C. Hamacher *In its* Theory of Adaptive Mech. Nov. 1966 p 69–100 refs (See N67-18447 08-08) CFSTI: HC $3.00/MF $0.65

Specific examples of one and two dimensional iterative arrays of Hennie type are shown and the relative computing power of the classes that they represent is described. The relationship between iterative arrays and pattern recognition techniques is discussed. The fastest binary multiplier, usually called the simultaneous multiplier, is given a full iterative formulation which is particularly useful for specifying logic requirements and describing circuit action. A theorem about a sufficient set of nearest neighbor connections for a certain class of real-time processing operations

in Cole type arrays is proven in one, two and three dimensions and a constructive technique for the N-dimensional proof is conjectured. In all dimensions, the theorem shows that the euclidean neighbor structure of Hennie is the sufficient set. Author

N67-18451# Syracuse Univ. Research Inst., N. Y.
COMPUTERS AND FORMAL SYSTEMS, PART 5
W. S. Bennett *In its* Theory of Adaptive Mech. Nov. 1966 p 101–111 refs (See N67-18447 08-08) CFSTI: HC $3.00/MF $0.65

This paper presents a discussion of the possibility of using formal mathematical systems—in particular the first order predicate calculus—as tools for improved digital computer designs. The justification for this approach and its possible advantages are discussed, and the transformation of behavioral descriptions of computer components from natural languages to formal language is illustrated. Author

N67-18573# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SCIENTIFIC TECHNICAL INFORMATION Selected Articles
9 Sep. 1966 44 p refs Transl. into ENGLISH from Nauchn.-Tekhn. Inform. (USSR), no. 2, 1964 p 34–43
(FTD-TT-66-113; TT-67-60273; AD-643979) CFSTI: HC $3.00/MF $0.65

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1. EXTRACTION OF INFORMATIONAL INVARIANT SIGNS DURING AUTOMATIC READING V. P. Romanov p 1–17 refs (See N67-18574 08-08)
2. PROBLEMS OF FIXING NAMES OF OBJECTS G. S. Tabidze p 18–36 refs (See N67-18575 08-08)

N67-18574 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
EXTRACTION OF INFORMATIONAL INVARIANT SIGNS DURING AUTOMATIC READING
V. P. Romanov *In its* Sci. Tech. Inform. 9 Sep. 1966 p 1–17 refs (See N67-18573 08-08) CFSTI: HC $3.00/MF $0.65

Methods for obtaining descriptions of signs during automatic reading are considered as calculations of linear equations, and an analysis is presented of signs connected with the description of their contour in natural form for cases with and without noise. The application of integral geometry methods is proposed, specifically the use of a Radon tranformation for the description of the sign. This transformation permits the change of assignment of the image in the space of points to its assignment in the space of straight lines. In this way the connectedness and other structural properties of an image can be found, and the extraction of invariant signs can be facilitated. M.W.R.

N67-18575 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PROBLEMS OF FIXING NAMES OF OBJECTS
G. S. Tabidze *In its* Sci. Tech. Inform. 9 Sep. 1966 p 18–36 refs (See N67-18573 08-08) CFSTI: HC $3.00/MF $0.65

Methods are discussed that can overcome some of the difficulties occurring during the selection of names for a group of words that designate either individual objects or the properties of these objects. Words were separated into those designating the object and those designating the action, and certain secondary words were also separated into two similar groups. Functions of the search, listing, and other operators employed are described. In general, the algorithm of fixing and separating names in a text is considered to include three parts: (1) general rules to determine operation and the interaction of the parts of the algorithm, (2) dictionary of characteristic word forms, and (3) information tables to obtain the required identification forms. These are discussed, and a system of describing syntactic bonds is analyzed. M.W.R.

N67-18721*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
USE OF ANALOG COMPUTATION IN PREDICTING DYNAMIC TEMPERATURE EXCURSION OF ORBITING SPACECRAFT
Frank J. Capollina Washington, NASA, Feb. 1967 25 p refs
(NASA-TN-D-3712) CFSTI: HC $3.00/MF $0.65 CSCL 09B

Presented herein is an analog computer program capable of predicting an orbiting spacecraft's external surface temperatures. By dividing a spacecraft's external surface into sections and applying transient heat transfer and thermodynamic equations to the boundaries of each section, an analog circuit describing the total incident energy as a function of spacecraft orbital position is written. The source of the external incident energy simulated can be from any combination of solar radiation, earth albedo, earth thermal emission, solar paddle emission and reflection. The sources of internal energy incident to the inner surfaces can be from instrument power dissipation, and from radiation interchange between adjacent and opposite surfaces. Using the advanced orbiting solar observatory spacecraft as the thermal model, the analog computer solution is shown for the parameters involved. Author

N67-18750*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
SPACE SCIENCES DATA PROCESSING
George H. Ludwig Nov. 1966 19 p refs Presented at the 13th IEEE Nucl. Sci. Symp., Boston, 9–21 Oct. 1966
(NASA-TM-X-55690; X-560-66-528) CFSTI: HC $3.00/MF $0.65 CSCL 09B

Information system problems are discussed from the standpoint of the experimenters who are the users of the system. The discussion is restricted to one class of spacecraft, the NASA managed and operated space sciences satellites. The term information system refers to the electronic systems which collect the outputs from the experiment sensors on the spacecraft, process these data on the spacecraft, transfer them to the ground receiving stations, and prepare the information in suitable form for the experimenters so that they may reach conclusions about the phenomena being measured. A generalized information system for space experiments is illustrated. Focused upon are three areas of the generalized data system: onboard data processing and reduction; central data processing on the ground; and data reduction which provides the necessary outputs for analysis. S.C.W.

N67-18778# Oak Ridge National Lab., Tenn.
ALPHA M—AN IMPROVED COMPUTER PROGRAM FOR DETERMINING RADIOISOTOPES BY LEAST-SQUARES RESOLUTION OF THE GAMMA-RAY SPECTRA
Ernest Schonfeld Sep. 1966 44 p refs
(Contract W-7405-ENG-26)
(ORNL-3975) CFSTI: HC $3.00/MF $0.65

Alpha M is an improved version of program Alpha--more versatile, more accurate, and also reduces the cost per determination. Fewer counts per channel are required, variations of the background are compensated for, computation time is reduced, results of consecutive spectra can be added, and initial conditions can be changed. A further improvement over Alpha is that the new program includes instructions for use with FORTRAN II, 62, 63, and IV languages and several digital computers--CDC-1604, -3800, IBM-7094/0, and -360. Author (NSA)

N67-18896# Argonne National Lab., Ill. Applied Mathematics Div.
GYRO II: A MACRO-DEFINED SYSTEM FOR LIST PROCESSING

Daniel F. Carson and George A. Robinson May 1966 38 p refs
(Contract W-31-109-ENG-38)
(ANL-7149) CFSTI: HC $3.00/MF $0.65

A formal description of the GYRO II language is presented and the implementation for the Control Data 3600 at Argonne National Laboratory is discussed. Author (NSA)

N67-18971*# System Development Corp., Dayton, Ohio.
DEVELOPMENT AND APPLICATION OF COMPUTER SOFTWARE TECHNIQUES TO HUMAN FACTORS TASK DATA HANDLING PROBLEMS Final Report, 21 Jun. 1965–21 Jun. 1966
K. W. Potter, A. T. Tulley, and Lawrence E. Reed (AMRL) Wright-Patterson AFB, Ohio, AMRL, Dec. 1966 73 p refs
(NASA Order R-115; Contract AF 19(628)-3418)
(NASA-CR-82368; AMRL-TR-66-200) CFSTI: HC $3.00/MF $0.65 CSCL 09B

The application of techniques for handling data generated in support of aerospace system development programs is discussed. It is recognized that the techniques must be developed in context with their total operative environment. A concept of an operational data management system for storing, processing, and retrieving human factors task data in a government–contractor environment is discussed and illustrated. This concept is predicated on the assumption that a user-oriented computerized data system will help draw human factors specialists closer to their data. Five problem areas, considered to be fundamental to the development of data handling techniques, were researched. These areas are: (1) analysis of human factors task data, data relationships, and classification schemes; (2) application of vocabulary and thesaurus techniques to increase the effectiveness of communication among man–machine–software functions; (3) application of computer storage and retrieval techniques to human factors task data; and (4) application of current awareness techniques to provide notifications of data availability. Author

N67-18994*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
APOLLO REMOTE SITE DATA PROCESSOR SYSTEM
William E. Willis, Jr. *In its* Apollo System Jun. 1966 p 7–10 (See N67-18991 08-07) CFSTI: HC $3.00/MF $0.65

Two identical computing subsystems will be installed on each of the Apollo tracking network sites. One computer subsystem will be used for the processing of telemetry data and will also provide a command processing back-up capability. The second subsystem will be used for the processing of command data and will also provide a telemetry processing back-up capability. The purpose of the Apollo command computer is to provide a means of communicating with and controlling the spacecraft equipment from the ground. The telemetry computing system will initially interface with three PCM decommutation stations, and data inputted to the computer will be derived from the PCM telemetry serial bit stream after being processed through the PCM system. The specific items of equipment that will be utilized in each remote site computing system are listed. A.G.O.

N67-18999*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
APOLLO REMOTE SITE COMPUTER PROGRAMMING
Paul J. Pashby *In its* Apollo System Jun. 1966 p 23–26 (See N67-18991 08-07) CFSTI: HC $3.00/MF $0.65

Consideration is given to the software necessary to integrate hardware subsystems into a unique tool for mission control. Depending on the type of peripheral equipment associated with computers at the sites, a number of different computer programs will be required. Because many specific programs will be written, this report is limited to a description of the highest level program for both "telemetry/display" and "command" processes. The typical response of each program to perform a basic flight control task is depicted. A.G.O.

N67-19002*# Los Alamos Scientific Lab., N. Mex.
PROGRAMS DESIGNED FOR PROCESSING MONTE CARLO EVENTS TAPES
J. Robert Streetman 15 Jul. 1966 36 p refs
(Contract W-7405-ENG-36)
(LA-3530-MS) CFSTI: HC $3.00/MF $0.65

A program is described for processing events tapes from a neutron Monte Carlo calculation. The saving of the events of a Monte Carlo on tape for possible future processing is a useful technique in that the original program need not go to such lengths to be comprehensive in the data accumulated. The program described is capable of regenerating the information originally accumulated by the Monte Carlo and has been used to collect additional information the need for which was not foreseen when the Monte Carlo was run. Author (NSA)

N67-19060*# Union Carbide Corp., Oak Ridge, Tenn. Computer Sciences Center.
AN APT POST PROCESSOR FOR POSITIONING MACHINES
M. G. Buchanan and R. J. Easterday 29 Sep. 1966 204 p
(Contract W-7405-ENG-26)
(K-1675) CFSTI: HC $3.00/MF $0.65

The APT Post Processor for positioning machines is a generalized post processor that produces command tapes for numerically controlled positioning machines. It provides a basic framework that allows easy implementation of new machines. Author (NSA)

N67-19106* Oak Ridge National Lab., Tenn.
DESCRIPTION OF THE TERP SYSTEM, A FORTRAN II/63, IV/63, 360 SYSTEM FOR EFFICIENT INTERPOLATION
D. I. Putzulu, P. Aebersold, and W. R. Burrus 8 Dec. 1966 149 p
(NASA Order R-104(1))
(NASA-CR-82664; ORNL-TM-1706) CFSTI: $3.00 CSCL 09B

When repetitive calculation of complicated or nonlibrary functions is anticipated, use of an efficient numerical approximation is highly desirable. The system to be described (TERP) provides a means for obtaining such an approximation when the user can furnish routines to calculate the functions he desires. The entire system is available in Fortran. For increased speed, a machine-coded version of the interpolation routine is also included for 7090-Fortran-II, 7090-Fortran-IV, CDC-1604 Fortran-63, and 360-Fortran. Using these hand-coded routines, the time required for interpolation is 255 μsec (IBM-7090), 107 μsec (IBM-7094-II), 441 μsec (CDC-1604A), and 45 μsec (IBM-360). The system works by table lookup and parabolic interpolation, and its accuracy depends on the functions and on the number of storage locations allocated for the table. For example, the function ERF (X), $0 \le X \le 4.5$, can be reproduced to 0.002% with 250 storage locations or to 0.00005% with 450 locations. The system can produce symbolic language (FAP, MAP, CODAP-2, or 360 assembly) decks for computing the functions and/or their inverses (backward interpolation). The function values may be obtained from these decks by Fortran statements such as Y=ERF(X), and X=ERFBAK(Y), where the names are chosen by the user. Author

N67-19163*# Auburn Univ., Ala. Dept. of Industrial Engineering.
COMPUTER AND DATA PROCESSING SYSTEM WORKLOAD ANALYSIS Final Report

Dec. 1966 83 p
(Contract NAS8-18049)
(NASA-CR-82570) CFSTI: HC $3.00/MF $0.65 CSCL 09B

A workload analysis of data processing jobs executed on peripheral equipment at the Marshall Space Flight Center is presented. Data is analyzed on peripheral equipment utilization, and a workload mathematical simulation model is outlined. Included are procedures followed throughout the study, data summaries made in the study, a description of the mathematical simulation model, and results of preliminary runs with the model. C.T.C.

09 ELECTRONIC EQUIPMENT

Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation.

N67-18286# Chalmers Univ. of Technology, Goteborg (Sweden). Research Lab. of Electronics.
NONLINEAR MICROWAVE TUBE STUDIES Final Scientific Report
S. Olving 1 Sep. 1966 40 p refs
(Contract AF 61(052)-594)
(RADC-TR-66-796; RR-71; AD-643322) CFSTI: HC $3.00/MF $0.65

The report gives a resume of the sixteen technical notes. Theories were developed for nonlinear distortion phenomena in klystrons, traveling wave tubes, plasma amplifiers and microwave vacuum diodes. Experimental work is also described. Frequency multiplication effects in cyclotron wave tubes are studied. Generalized laws for electromagnetic energy, power flow and boundary conditions in dispersive media were formulated. Author (TAB)

N67-18299# Illinois Univ., Urbana.
A DISTORTION ANALYSIS OF THE MOS TRANSISTOR
Robert F. Pfeifer and C. T. Sah Jun. 1966 28 p refs
(Grant AF-AFOSR-714-65; Order ARPA SD-131)
(AFOSR-66-1340; AD-641306) CFSTI: HC $3.00/MF $0.65

The experimental results verify the theoretical expressions considerably well when the equations are evaluated within their respective regions of validity. The deviation from the V sub G dependance of i sub d1 which is seen to extend into the saturation region by an amount greater than the modulation width of the input signal is assumed to be due to the approximation of zero drain conductance at the edge of the saturation region. The practical results of this experiment indicate that the MOS transistor can perform satisfactorily as a low distortion amplifier when operated in the saturation mode provided that the input signal is maintained at a sufficiently low level. The properties of the square law behavior for the saturation mode can be used most advantageously in the construction of an analog squaring circuit. For this application, the test circuit of Figure 5 can be used if an additional notch filter is inserted in the output circuit to remove the fundamental frequency of the output signal. The output signal can then be conveniently measured with an rms a-c voltmeter and will vary as the square of the input signal. Author (TAB)

N67-18344*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
EXPERIMENTAL RESULTS OF MULTIPACTING BETWEEN COAXIAL ELECTRODES WITH HIGH B/A VALUES
R. Woo *In its* Space Programs Sum. no. 37-42, vol. IV 31 Dec. 1966 p 182-183 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

Experimental results are presented to demonstrate the scaling laws of the similarity principle for coaxial electrodes where the ratio of outer to inner radii, b/a, varied up to 18.26. Observations show that for b/a = 2.3 the electric fields are relatively uniform and higher modes can exist. As b/a is increased, the fields become more nonuniform and higher order modes cannot exist. It is emphasized that although the multipacting regions for the higher b/a ratios are similar, the multipacting mechanism need not be. Data for two sets of electrodes of different sizes and b/a = 9.13 are plotted; the dimensions of one set are twice the dimensions of the other set. As in the case of b/a = 2.3, the minimum energy boundary decreases with a decrease in electrode size. M.G.J.

N67-18424# Manufacture Belge de Lampes et de Material Electronique, Brussels (Belgium).
EVALUATION OF VARACTOR PERFORMANCES FOR PARAMETRIC AMPLIFIERS USED IN THE RECEIVER SYSTEM OF THE DOWN RANGE GUIDANCE STATION
J. C. Lienard In ELDO ELDO Tech. Rev., Vol. 1, No. 2 1966 p 115-128 (See N67-18421 08-31) CFSTI: HC $3.00/MF $0.65

The choice of a reflection type amplifier is justified. The gain and noise figure formulae of such a device are given. A summary of the varactor pumping theory leads to elastance, pump power, and polarization expressions for voltage and current pumpings. A brief study is given of noise figure optimization, pump power requirements, bandwidth, and input impedance. The design and performances of ELDO parametric amplifiers are summarized. Author (ESRO)

N67-18460*# Army Missile Command, Huntsville, Ala.
DIFFERENTIATION CIRCUITS FOR AMPLITUDE-MODULATED SIGNAL ENVELOPES
V. I. Anisimov and Yu. F. Likhodiyevskiy 16 Aug. 1966 8 p refs Transl. into ENGLISH from Priborostroenie (Moscow), v. 7, no. 5, 1964 p 41-46 Joint Rept. with NASA
(NASA-TM-X-59391; RSIC-583; TT-66-62443; AD-640308) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Two differentiation circuits for amplitude-modulated signal envelopes in which the functions of the modulator and the demodulator are accomplished by one switch are examined in this article. A serious problem arising during the designing of a system with signal modulation is the creation of economic and stable compensation circuits. There are two basic methods of compensation circuits which operate on alternating current. The first method is compensation by sections of alternating current which are different resonance circuits tuned to the carrier frequency. On the strength of this such circuits are extremely critical to changes of the carrier frequency and magnitudes of the self-capacitances, inductances, and resistances. The second method is compensation with double conversion of the signal frequency. Author (TAB)

N67-18467# California Univ., Livermore. Lawrence Radiation Lab.
EXPLOSIVELY-ACTIVATED HIGH-VOLTAGE SWITCH FOR ASTRON FAST-PULSE SYSTEM
Leslie F. Peterson and James H. Cooper 23 Sep. 1966 8 p Presented at the Symp. on Eng. Probl. of Controlled Thermonucl. Res., Gatlinburg, Tenn., 3-6 Oct. 1966 Submitted for Publication
(Contract W-7405-ENG-48)
(UCRL-70030; CONF-661016-10) CFSTI: HC $3.00/MF $0.65

The Astron fast-pulse system is designed to provide the Astron experiment accelerator with burst rates of 1440 pulses/sec. In the event of malfunctions in the capacitor bank or modulator portions of the system, high currents may flow in part or all of the capacitor bank charging diodes until the main circuit protective breaker removes the entire system from the line. As a means of

minimizing the voltage on the diodes and limiting the energy which could be put into the diodes under fault conditions, a fast-acting, explosively actuated, high-voltage switch was designed to short the 3-phase supply to the diodes within a few msec of the fault. NSA

N67-18548*# Lockheed-Georgia Co., Marietta. Nuclear Lab.
COMPONENTS IRRADIATION TESTING NO. 19, GAMMA IRRADIATION OF 2N914, 2N918, S2N930, 2N2192 AND 2N2369 TRANSISTORS
Oct. 1966 106 p refs
(Contract NAS8-5332)
(NASA-CR-82010; ER-8623) CFSTI: HC $3.00/MF $0.75 CSCL 09A

NPN silicon planar epitaxial transistors were subjected to gamma irradiation and failure points (gamma dose when 50% degradation of h_{FE} occurred) were determined. The specimens were then temperature annealed and gamma irradiated a second time to failure along with type S2N930 specimens from a previous test. Investigations were made on possible correlations between pre-irradiation values h_{FE}, T_a and I_{EBO} and radiation tolerance exhibited during the first irradiation. Recovery of radiation induced degradation of h_{FE} at room temperature after small doses of gamma irradiation was investigated, and comparison was made between failure points shown during the first irradiation and those shown during the second irradiation. Test results indicated that NPN silicon transistors can be pre-selected for use in a gamma radiation environment by subjecting the devices to comparatively small doses of gamma radiation and computing percentage losses of h_{FE}. The pre-selected devices will have a minimum radiation lifetime about one order of magnitude, or more, greater than the screening dose. Author

N67-18568# Lessona Corp., Great Neck, N. Y.
INTERNAL REFORMING OF LIQUID HYDROCARBON FUELS Interim Report, 9 Feb.–9 Sep. 1966
W. R. Alcorn, J. R. Dafler, and S. Cohen Oct. 1966 41 p refs
(Contract DA-44-009-AMC-1501(T))
(AD-643014) CFSTI: HC $3.00/MF $0.65

Theoretical and experimental studies of the integrated anode in the internal-reforming hydrocarbon-air fuel cell were conducted. Catalyst activity, reaction kinetics and mass transfer effects were evaluated with two experimental systems: a one-inch anode cell and a packed-bed reactor. A computer program was prepared to determine equilibrium gas compositions obtained in hydrocarbon reforming. 1.5 and 1.0-mil Pd/Ag membranes were activated on the gas-side with various combinations of deposited metals to determine their reforming capacity and hydrogen extraction efficiency at low pressures. Reforming capacity was very low. On the basis of limited data, hydrogen extraction efficiency appears to be somewhat improved by certain combinations of Pd, Ni, and Co. Reactor studies indicated that significant delay of catalyst reforming activity is probably associated with deposition of carbon, in some form, during reforming. Little or no effect of sulfur compounds on activity was observed. Author (TAB)

N67-18571# Computer Control Co., Inc., Framingham, Mass.
EVALUATION OF FLIP/CHIP INTEGRATED CIRCUIT INTERCONNECTIONS Interim Development Report, 14 Oct. 1965–14 Jan. 1966
14 Feb. 1966 22 p
(Contract Nobsr-95052)
(AD-640670) CFSTI: HC $3.00/MF $0.65

The initial study of some of the basic constraints to be applied to Flip/Chip modules has been completed. Masks for the preparation of experimental samples have been designed and sample substrates and chips are being prepared. Ultrasonic welding equipment has been installed and is operational. A few samples have been bonded. Author (TAB)

N67-18603# California Univ., Berkeley. Lawrence Radiation Lab.
COMPUTER-CONTROLLED 4096-CHANNEL SEMICONDUCTOR DETECTOR SYSTEM WITH STABILIZATION
Stefan P. Swierkowski and Robert W. Lefore 18 May 1966 18 p refs Presented at the 22d Natl. Electron. Conf. and Exhibits, Chicago
(Contract W-7405-ENG-48)
(UCRL-16814; CONF-661007-1) CFSTI: HC $3.00/MF $0.65

The construction and operation of the hardware and software that constitutes a 4,906 channel biastabilized pulse-height analyzer, data processing, and control system are described. The system was designed for studying γ-ray spectra at the 184 in. cyclotron. Author (NSA)

N67-18626*# Westinghouse Electric Corp., Pittsburgh, Pa. Research and Development Center.
VACUUM SWITCHGEAR–A SURVEY
W. S. Emmerich 1967 41 p refs Prepared for NASA
(NASA-SP-5063) GPO: HC $0.35; CFSTI: MF $0.65 CSCL 09A

A survey of the literature and NASA sponsored reports on vacuum switchgear is reported. Cited are two NASA sponsored studies dealing directly with the basic technology underlying ultrahigh vacuums suitable for applications as vacuum interrupters: studies of adhesion mechanisms and the effect of surface preparation; pressure measurements; cathode and arc phenomena; and hardware development (NASA supported vacuum switchgear development and the present status of commercial devices). An analysis of unsolved switching problems and requirements is also included. S.C.W.

N67-18909*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
MANUFACTURING AND QUALITY CONTROL REQUIREMENTS FOR SPACE SYSTEMS ELECTRICAL HARNESSES
6 Jul. 1965 38 p
(NASA-TM-X-59404; SR-QUAL-65-25) CFSTI: HC $3.00/MF $0.65 CSCL 09A

This document outlines processes, based on new design concepts, which have been developed to assure maximum reliability of space systems electrical harness. Author

N67-18912# Rome Air Development Center, Griffiss AFB, N. Y. Research and Technology Div.
RELIABILITY IN MICROELECTRONICS
Joseph B. Brauer Oct. 1966 14 p refs Presented at the IEEE Microelectronics Symp., St. Louis, 19–20 Jul. 1966
(RADC-SP-66-3; AD-644195) CFSTI: HC $3.00/MF $0.65

The paper reviews the current and anticipated future reliability requirements for microelectronic devices and compares these to the present reliability levels. The quality problem as it affects reliability is discussed in some detail. Data is derived from various equipment development programs and investigations of integrated circuit quality and reliability. In recognition of the fact that the produce (microelectronic devices) does not yet meet the promise, some of the problems and interim solutions are discussed in detail. The effectiveness of various acceptance and screening procedures for integrated circuits is evaluated. Author (TAB)

N67-18926*# National Aeronautics and Space Administration, Washington, D. C.
A NANOSECOND LIGHT-PULSE GENERATOR WITH EXTERNAL SYNCHRONIZATIONS [GENERATOR NANOSEKUNDNYKH IMPUL'SOV SVETA S VNESHNEY SINKHRONIZATSIYEY]

A. P. Onuchin Jan. 1967 8 p refs Transl. into ENGLISH from Pribory i Tekhn. Eksperim. (Moscow), no. 4, Jul.–Aug. 1966 p 97–101
(NASA-TT-F-10662) CFSTI: HC $3.00/MF $0.65 CSCL 09A

A generator of light pulses of approximately 1 nsec is described. External synchronization accuracy is better than 0.3 nsec; amplitude stability is no worse than 5%; service life is not less than 500 hr, at a frequency of 2.5 kHz. The technique of manufacturing the discharger is described. The relationship is given between pulse length, interelectrode distance, and gas pressure. The influence of the quality of the electrode surface, frequency of pulse sequence and overvoltage on synchronization accuracy is examined. Author

N67-18946*# TRW Systems, Redondo Beach, Calif.
STUDY HIGH DIELECTRIC CONSTANT THIN FILM CAPACITOR MATERIALS Final Report
R. P. Radke 26 Jan. 1967 73 p refs
(Contract NAS9-5592)
(NASA-CR-65597; TRW-06278-6001-R000) CFSTI: HC $3.00/MF $0.65 CSCL 09A

The high vacuum approach for thin film capacitors with high specific capacitances was investigated in order to permit reductions in the size of microcircuits. In general, materials of the ABO_3 type and having dielectric constant "k" were considered. Various depositional approaches were explored, and the physics, crystallography, and chemistry of the resultant thin films were established by utilization of optical and electron microscopy, X-ray diffraction, and spectrographic analysis. Electrical characteristics of the thin films when utilized as capacitor dielectrics were established with regard to temperature coefficient of capacitance, specific capacitance, dielectric constant, frequency response, voltage breakdown characteristics, and stability. The "molten sphere" deposition method is reported to have shown high potential for successful fabrication of high dielectric constant thin film capacitors of sodium niobate. The technique is especially advantageous from the standpoint of eliminating contamination from a refractory metal source. A.G.O.

N67-19006# Massachusetts Inst. of Tech., Cambridge. Lab. for Insulation Research.
A CAPACITANCE BRIDGE ASSEMBLY FOR DIELECTRIC MEASUREMENTS FROM 1 Hz to MHz
R. E. Charles K. V. Rao, and W. B. Westphal Oct. 1966 31 p refs
(Contracts Nonr-1841(10); AF 33(616)-8353)
(TR-201; AD-643169) CFSTI: HC $3.00/MF $0.65

A capacitance bridge is described for measurement of two-thermal capacitors to 80 pf with a nominal loss-tangent sensitivity of 10.000001 radians for samples >10 pf. Provisions for three-terminal measurements are included for frequencies from 1 to 100,000 Hz. Author (TAB)

N67-19037*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
INDUSTRIAL SURVEY OF ELECTRONIC PACKAGING
J. L. Easterday, D. A. Kaiser, and C. H. Burley Redstone Arsenal, Ala., Redstone Sci. Inform. Center, 30 Nov. 1966 135 p refs
(Contract DA-01-021-AMC-14693(Z))
(NASA-TM-X-59418; RSIC-614) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Information provided is a review of electronic packaging techniques ranging from the mounting of parts (discrete or integrated circuit) to a complete black box. Module configurations discussed include planar printed-circuit boards, stick modules, cordwood, mylar tapes for part mounting, and variations of these. Package configurations have been aimed at reducing the number of layers in multilayer printed-circuit boards. Techniques include book type modules interleaving printed-circuit boards, slotted guides in housings, and precompressed stacks of printed-circuit board assemblies. The package housings may be cast, dip brazed, automatically milled from solid stock, or light sheet metal covers. Many types of interconnection techniques are in use including multilayer circuitry other than conventional printed-circuit boards. Eyelets and plated-through holes are usually reinforced by filling, redundancy, etc. No great variations in potting methods were noted except for radio frequency modules. However, problems of nonuniform density were indicated. Author

N67-19039*# RCA Victor Co., Ltd., Montreal (Quebec). Technical Products Engineering.
REPORT FOR PROGRAM OF COMPARATIVE TEST AND MEASUREMENT OF HIGH POWER KLYSTRONS AND TRAVELLING WAVE TUBES Report, Oct. 1964–Feb. 1965
Aug. 1965 341 p refs Prepared in Cooperation with Varian Associates, Palo Alto, Calif.
(Contract NASw-1003)
(NASA-CR-82473) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Comparative measurements performed on two clover-leaf traveling wave tubes and two multicavity klystrons in the 6 Gc frequency band are described. Power output, bandwidth, gain, group delay, derivative linearity (AM & FM), NPR and AM to PM conversion were the most important characteristics measured or calculated. Complete test setups are given, including calibration procedure. The use of identical test gear and techniques permits direct comparison of results. Neither the TWT nor the klystron has a clear-cut superiority when all important characteristics are considered. Both types show low AM to PM conversion (1 to 5°/dB) and acceptable derivative linearity (10–50%), depending on tuning and output power. From a purely performance point of view (neglecting frequency range, power output, number of supplies etc), the TWT appears to be better for SSB service. Klystrons have advantages for FM usage up to 20–25 Mc signal bandwidth. Both devices have excellent noise power ratios in excess of 40 dB. Author

N67-19141*# Sprague Electric Co., North Adams, Mass.
QUALIFICATION TESTING STUDY AND TEST PROGRAM FOR INTEGRATED CIRCUITS Quarterly Report, Apr. 1–Jun. 30, 1966
15 Jul. 1966 36 p
(Contract NAS8-20254)
(NASA-CR-82573; QR-4) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Performance qualification testing was carried out on four microcircuit types, and additional studies to determine the effectiveness of the screening methods and tests were conducted. Results from the quality assurance experiments are discussed including failure analysis. A review of the screening, qualification and process specifications is also presented. A.G.O.

N67-19276*# General Motors Corp., Santa Barbara, Calif. Physical Sciences Dept.
EXPERIMENTAL RESEARCH ON THE ELECTRIC VACUUM GYRO Final Technical Report
Oct. 1966 43 p
(Contract NAS12-28)
(NASA-CR-80013; TR66-52) CFSTI: HC $3.00/MF $0.65 CSCL 09C

Development of electronic circuitry for suspending an electric vacuum gyro (EVG) rotor in the center of its electrode sphere is described. The suspension differs from previous circuitry in that

the currents that develop the varying forces required to keep the rotor centered under acceleration loadings are supplied by varying the phase between two constant currents rather than summing a constant and a variable current. This "phase modulation" approach has many important advantages over the "amplitude modulation" approach and its feasibility has been completely demonstrated. The circuit features are discussed in detail, with complete schematics and suspension adjustment procedures included. Author

10 ELECTRONICS

Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories.

N67-18288# Pennsylvania State Univ., University Park. Ordnance Research Lab.
PERFORMANCE OF THIRD-ORDER NONLINEAR CONTROL SYSTEMS
R. Waste 3 Oct. 1966 112 p refs
(Contract NOw-65-0123-d)
(TM-638.2141-02; AD-643348) CFSTI: HC $3.00/MF $0.65

This thesis investigates a method of predicting the step response of control systems described by third-order nonlinear differential equations. The nonlinearities are specified mainly as being smooth and not a function of the derivatives of the dependent variable. The method is based on the construction of a root excursion plot, which is the locus, in a root vs. dependent-variable plane, of the roots of a nonlinear characteristic equation. Various possible shapes of third-order root excursion plots are examined, and the step response of the system is related to each particular shape. In particular, it is possible to predict the exact value of system gain or step amplitude which will yield the fastest possible no-overshoot response. Advantages of the method are mainly that the number and location of the nonlinearities are not limited. The prediction of the response is not restricted to a small range immediately around an equilibrium point. That is, for the cases in which the method does apply, if the system is stable over an extended range, the point of the fastest no-overshoot response within that range can be predicted very accurately. Presently, there are no other methods available which will yield response information of this type. A possible extension of the method to higher-order nonlinear systems is demonstrated by several fourth-order examples. Author (TAB)

N67-18294# Northwestern Univ., Evanston, Ill. Information-Processing and Control Systems Lab.
SOME GENERALIZATIONS OF THE DISCRETE OPTIMAL CONTROL PROBLEM
S. G. Bankoff Oct. 1966 33 p refs
(Contract N00014-66-C0020-A03)
(TR-66-104; AD-643280) CFSTI: HC $3.00/MF $0.65

Some modifications of the Kuhn-Tucker constraint qualifications are given for non-linear programming problems where non-linear equality constraints are present. The treatment by Rosen of optimal discrete control problems is then generalized to include cyclic topologies. In addition, an approach to the discrete analog of the minimum-time problems is outlined. Author (TAB)

N67-18419* Texas Instruments, Inc., Dallas.
STUDY OF SOLID-STATE INTEGRATED MICROWAVE CIRCUITS Scientific Report, 15 Mar–14 Dec. 1966
31 Dec. 1966 242 p refs
(Contract NAS12-75)
(NASA-CR-80010; SR-3) CFSTI: HC $3.00 CSCL 09A

A study of the basic design techniques employed to define and develop a telemetry transmitter is presented. Separate sections of the report present an analysis of the system requirements and the selection of the basic transmitter configuration, the detailed design of the individual blocks in the transmitter, the laboratory work, and the effects of radiation on microelectronics. The appendix includes a survey of computer programs available to the design engineer and the computer programs used in the design of the gated discriminator AFC–FM transmitter. Author

N67-18448# Syracuse Univ. Research Inst., N. Y.
THRESHOLD GATE NETWORK SYNTHESIS, PART 2
E. P. Stabler *In its* Theory of Adaptive Mech. Nov. 1966 p 4–21 refs Presented at the 6th Ann. Symp. on Switching Theory and Logical Design, Mich. Univ., Ann Arbor, 6–8 Oct. 1965 Submitted for Publication (See N67-18447 08-08) CFSTI: HC $3.00/MF $0.65

A method of synthesizing networks of threshold gates is described. The method makes use of the solutions to the dual of a set of inequalities to guide the design. The procedure is suitable for a variety of network topologies, for multiple output networks, and for partially specified functions. The procedures described are suited to automatic computation. A program for performing logic design using these procedures has been written and tested. Author

N67-18543*# General Electric Co., Daytona Beach, Fla. Reliability and Quality Assurance Lab.
SINGLE PARAMETER TESTING Quarterly Report
Charles A. Grunden and John T. Sterling [1966] 44 p refs
(Contract NAS8-11715)
(NASA-CR-82006; Rept.-66-SIMAR-108/7) CFSTI: HC $3.00/MF $0.65 CSCL 09C

Techniques for solving a variation of the identification problem were investigated. The general problem consists in determining the input-output relationships of a black box by experimental means. The form of the identification problem was the determination of deviations of the parameters of a component from their nominal values. Two techniques were investigated: (1) the use of growing exponentials as the input probing signal, and (2) the use of transient response sampling. Both linear and nonlinear component models were studied to establish the range over which accurate parameter predictions could be made. The final phase of the program involved applying the developed techniques to ac and dc amplifiers with the objective of measuring the transfer function parameters and, therefore, the frequency response characteristic. Also investigated was a technique for measuring amplifier linearity. The study shows that single parameter testing techniques can be applied to some components. Technical and economic considerations for the selection of a component to be tested when using these techniques are described. Author

N67-19031*# General Electric Co., Syracuse, N. Y. Electronics Lab.
SOLID STATE IMAGE SENSOR RESEARCH, PHASE I
G. C. Gerhard, R. E. Glusick, S. Rasi, and R. D. Stewart [1966] 42 p refs Prepared in Cooperation with GE, Philadelphia, Pa.
(Contract NAS12-131)
(NASA-CR-82478) CFSTI: HC $3.00/MF $0.65 CSCL 09C

The capabilities and limitations of image sensing systems in the 0.4 to 15 micron wavelength band were determined and studied. It was established that the bands of greatest interest were the visible, the 2.5–5 micron band, and the 10–12 micron

band. The studies undertaken included both the detectors and the readout capabilities required to adequately and optimally use the detectors in array operation. Cooling of the arrays and the scanning electronics is a necessary part of the IR systems and was included in the evaluation. This report first details the detector materials, fabrication techniques and electronic scanning requirements; then, a set of conclusions and recommendations are given for future development and anticipated results in the three spectral bands of interest. Author

N67-19041*# Stanford Univ., Calif. Dept. of Aeronautics and Astronautics.
ANALYTICAL DESIGN OF MANNED CONTROL SYSTEMS
Walter George Eppler, Jr. (Ph.D. Thesis) May 1966 187 p refs
(Grant NsG-133-61)
(NASA-CR-82370; SUDAAR-280) CFSTI: HC $3.00/MF $0.65 CSCL 09C

The problem of designing high-performance closed-loop control systems which include a human operator is considered. The approach considers display to the operator, processing of the operator's responses to the display, and the operator's response that limits the performance of the system. The control action display approach consists of adding a separate feedback loop around the display, operator, and control device sections of a conventional system. Control action display simplifies the operator's control function by requiring only that he track the system errors with the controller outputs (over which he has instantaneous and exclusive control). The control action display principle is demonstrated by a spacecraft attitude control system. In another example the display is applied to the analytical design of a manned system in which the controlled element is inherently unstable. The case considered is a variation of the tightrope-walker attitude control system. Also described is the inner-loop performance obtained experimentally using various operator outputs for control action display. S.P.

N67-19083*# Arizona Univ., Tucson. Engineering Experiment Station.
DESIGN OF LINEAR AND NONLINEAR CONTROL SYSTEMS VIA STATE VARIABLE FEEDBACK, WITH APPLICATIONS IN NUCLEAR REACTOR CONTROL
John W. Herring, Jr., Donald G. Schultz, Lynn E. Weaver, and Robert E. Vanasse Feb. 1967 130 p refs
(Grant NsG-490)
(NASA-CR-82516) CFSTI: HC $3.00/MF $0.65 CSCL 09C

A method for designing linear closed loop control systems, and nonlinear closed loop control systems having a single, memoryless, nonlinear and/or time-varying gain with an input-output characteristic confined to the first and third quadrants is developed. Nonlinear systems designed by this method have the properties of absolute stability and bounded outputs for bounded inputs for any nonlinear gain of the type considered. Systems in which the gain is time-varying also have these properties if the time-varying gain is constrained to a finite sector in the first and third quadrants. The linear part of the open loop system can have no more than one integration, and all other poles must have negative real parts. In its basic form, the design method requires that the nonlinear and/or time-varying gain be located at the input end of the plant to be controlled. The design procedure is based on feeding back all the state variables through constant linear gain elements. Results of an analog computer simulation are included. Author

N67-19182# Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.
SELF-ORGANIZING CONTROL SYSTEMS VOLUME 4: SYNTHESIS OF A TIME-OPTIMAL CONTROLLER THROUGH OFF-LINE TRAINING
J. J. Zapalac Aug. 1966 74 p refs
(DAC-59322)

This report reviews learning techniques used for training pattern classifiers and shows how this technology is used to derive a synthesis technique called off-line training. A demonstration is given whereby off-line training achieves a practical realization of the closed-loop time-optimal control law using a small set of open-loop time-optimal control laws. Author

N67-19259# National Bureau of Standards, Boulder, Colo.
ELECTRICAL PARAMETERS OF PRECISION, COAXIAL, AIR-DIELECTRIC TRANSMISSION LINES
Robert E. Nelson and Marlene R. Corvell 30 Jun. 1966 107 p refs
(NBS-Monograph-98) GPO: $1.25

Since precision coaxial connectors have become commercially available, precision, coaxial, air-dielectric transmission lines are being widely used as radio frequency immittance standards. The evaluation of seven electrical parameters for four different line sizes, which are commonly used as standards, are presented in graphic form. The seven parameters, evaluated as functions of frequency, are inductance per inch, resistance per inch, characteristic impedance magnitude, characteristic impedance phase angle, attenuation per inch, phase-shift per inch, and wavelength. Also included are graphs showing how these parameters vary with changes in the resistivity of the conductors, the relative dielectric constant of air, and the diameters of the conductors. Author

N67-19313* Purdue Univ., Lafayette, Ind. Control and Information Systems Lab.
ADVANCED CONTROL TECHNIQUES APPLIED TO LARGE FLEXIBLE LAUNCH VEHICLES, VOLUME I Final Report, 1 Jul. 1964–30 Jul. 1965
J. E. Gibson, J. C. Hill, V. Haas, A. S. Morse, S. Murtuza et al 30 Jul. 1965 206 p refs
(Contract NAS8-11416)
(NASA-CR-82594; TR-EE-65-10) CFSTI: HC $3.00 CSCL 09C

A study on the application of advanced control techniques to large flexible launch vehicles is presented. The report consists of six chapters and five appendices, titled: the minimax problem; the minimax principle; application of worst case error analysis to the design of a specific optimal control for a model vehicle; the application of linear programming to the optimal control of a model vehicle; adaptive control applied to a flexible vehicle; an annotated bibliography on adaptive control; equations of motion for the model vehicle; algorithms and subroutines for the solution of linear programming problems; a steep descent procedure for minimization problems; and minimum drift and minimum load control. Attempts are made to bring a wide variety of modern optimal control techniques to bear on the problem of controlling a large flexible launch vehicle. Some solutions are found for simplified models and a number of difficulties are pointed out. Recommendations for further study are given. Author

N67-19314* Purdue Univ., Lafayette, Ind. Control and Information Systems Lab.
ADVANCED CONTROL TECHNIQUES APPLIED TO LARGE FLEXIBLE LAUNCH VEHICLES, VOLUME II Final Report, 1 Jul. 1964–30 Jul. 1965
G. E. Gibson, J. C. Hill, V. Haas, A. S. Morse, S. Murtuza et al 30 Jul. 1965 124 p refs
(Contract NAS8-11416)
(NASA-CR-82593; TR-EE-65-11) CFSTI: HC $3.00 CSCL 09C

The mathematical model for a large launch vehicle is discussed in an introduction to the use of adaptive control concepts. Assumptions employed in the derivations are mentioned, and some

weaknesses in the model are pointed out. Based on the uncertainty of the model and on the wide diversity of the environmental conditions it is concluded that some form of adaptive or self-adjusting control system would be desirable. The flexible vehicle control problem is related closely to signal discrimination or state estimation. Tracking notch and digital adaptive filters are considered as avenues of approach to the solution of discrimination problems, and it is noted that model reference adaptive control appears to be the most versatile of all schemes evaluated. An annotated bibliography on adaptive control is also presented along with motion equations for the vehicle model, algorithms and subroutines for two interval control under the modified optimal control policy via linear programming, a steep ascent procedure for minimization problems, and minimum drift and minimum load control schemes. A.G.O.

N67-19340*# Philco Corp., Blue Bell, Pa. Applied Research Lab.
PHOTOMIXING DEVICES Third Summary Report, 15 Feb. 1965–15 Feb. 1966
B. Emmons 15 Mar. 1966 44 p refs
(Contract NAS8-5030)
(NASA-CR-82542; A045) CFSTI: HC $3.00/MF $0.65 CSCL 09C

Theoretical and experimental studies present information for use in the design and fabrication of solid-state optical heterodyne detectors that display current gain. To determine the effect of current multiplication on diode bandwidth, noise avalanching diodes and their frequency responses were investigated. Influence of the ratio of the electron to hole ionization coefficients on the variation of bandwidth with multiplication is reported. Experiments dealing with materials, guard-ring, and diode fabrication were conducted to obtain the largest possible current gain in InAs photodiodes for use with lasers in the 3-micron region. Sixteen mesa-type diodes show a current multiplication of the order of 10 at 10 volts reverse bias. The RC cutoff frequencies of the diodes range from 0.3 to 1.7 GHz for diode areas in the range from 2.4 to 10×10^{-4} cm^2. M.W.R.

11 FACILITIES, RESEARCH AND SUPPORT

Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands, shock tubes, and wind tunnels); test ranges; and tracking stations.

N67-18261# Aeronautical Research Council (Gt. Brit.)
The N.P.L. In. x 9 In. BOUNDARY-LAYER TUNNEL
P. Bradshaw and G. E. Hellens London, HMSO, 1966 50 p refs Supersedes NPL-AERO-1119; ARC-26296; see X65-18323 (ARC-R&M-3437; NPL-AERO-1119; ARC-26296) CFSTI: HC $3.00/MF $0.65

A description is given of the tunnel, which is of the closed-circuit type, with a top speed of 150 ft/sec and a 10 ft long working section, with a flexible roof for the production of any desired pressure gradient on the floor boundary layer on which the measurements are made. Results are given of a complete calibration of the working section and return circuit. Full details of the construction are given. Author

N67-18389# Phillips Petroleum Co., Idaho Falls, Idaho.
IMPROVED EQUIPMENT AND METHODS
In its Div. Anal. Branch for 1965 Jun. 1966 p 48–50 (See N67-18381 08-06)

Improved equipment and methods in the field of spectrochemical analysis are summarily reported. The installation of vacuum ion pumps on two single filament surface ionization mass spectrometers is mentioned, and it is pointed out that this has improved performance, peak shape, and resolution and has reduced cost. Brief details are also given on the installation of a microfocus X-ray diffraction unit, detection of hydrocarbons in reactor containment buildings, conversion of a vacuum system, restoration of the spectrograph for the SNAP test, analysis of deliquescent and pyrophoric samples by X-ray diffractometry, silver spark rotating-platform technique for spectrochemical determination of the rare earths, and installation of a vacuum lock on a tandem mass spectrometer. L.E.W.

N67-18393# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.
STANDARDS AND QUALITY CONTROL. UMPIRE QUALIFICATION PROGRAM
S. S. Yamamura, D. M. Lund, and J. E. Rein *In its* Div. Anal. Branch for 1965 Jun. 1966 p 60–63 (See N67-18381 08-06)

The initiation of an Umpire Qualification program in cooperation with various laboratories for the impartial settlements of differences between the Atomic Energy Commission (AEC) and industry regarding the fissionable material content is described. The basis of monetary payments or credits will be the quantity and quality of the materials involved as established by analysis. A number of materials will be exchanged for analysis, and qualification will be based on results of specially prepared standards. The implementation and status of the program are briefly outlined, and the functions of the AEC laboratory participants and future plans are presented in tabular form. L.E.W.

N67-18441 Aeronautical Research Council (Gt. Brit.)
A TECHNIQUE FOR THE WIND TUNNEL SIMULATION OF STORE RELEASE AT HIGH SPEEDS
L. J. Beecham London, Min. of Aviation, May 1964 24 p ref
(ARC-CP-856) CFSTI: HC $3.00

A controlled-fall technique for the wind tunnel simulation of the release of a store from an aircraft at high flight speeds is presented. It is shown that the trajectory and incidence of the store may be simulated during the release phase for transonic and supersonic free stream speeds by use of on-line incremental digital computation in conjunction with balance measurements. The technique allows in principle full three-dimensional freedom on the motions of both store and aircraft at launch. Author

N67-18494 Joint Publications Research Service, Washington, D. C.
AN ANECHOIC WATER TANK FOR HIGH FREQUENCIES
Wei-i Hsu *In its* Transl. on Communist China: Sci. and Technol., No. 354 14 Dec. 1966 p 1–6 refs Transl. into ENGLISH from Sheng-Hsueh Hsueh-Pao (Peking), v. 2, no. 1, Mar. 1965 p 39–40 (See N67-18493 08-23) CFSTI: $3.00

Characteristics of the free field in an anechoic water tank for use at high frequencies are plotted, as are the sound absorbing characteristics of walls and wedges. The equipment described, used for ultrasonics investigations, consists of the tank and a measurement coordinate set-up. The tank is made of one-centimeter-thick aluminum plates and has a volume of 80×90×150 cc. Sound absorbing materials installed on the six sides of the tank are made with gradually absorbing layers of sharp wood wedges. M.W.R.

N67-18529# Princeton-Pennsylvania Accelerator, Princeton, N. J.
FURTHER ENGINEERING DETAILS FOR FLAT-TOPPING THE PRINCETON-PENNSYLVANIA MAGNET

D. Huttar 17 Aug. 1966 35 p refs
(Contract AT(30-1)-2137)
(PPAD-597D) CFSTI: HC $3.00/MF $0.65

The system philosophy for flat-topping the PPA synchrotron, which has evolved, is presented. The results of engineering and model study efforts are discussed. NSA

N67-18535# California Univ., Livermore. Lawrence Radiation Lab.
DEVELOPMENT OF THE ASTRON FAST-PULSING SYSTEM
Kenneth A. Saunders 23 Sep. 1966 22 p refs Presented at the Symp. on Eng. Probl. of Controlled Thermonucl. Res., Gatlinburg, Tenn., 3–6 Oct. 1966 Submitted for Publication
(Contract W-7405-ENG-48)
(UCRL-70019; CONF-661016-13) CFSTI: HC $3.00/MF $0.65

The pulsing equipment for the ASTRON linear accelerator was modified to operate in a burst mode. This would provide a 100-pulse burst at a maximum rate of 1400 pps, with a long-term average pulse rate of 60 pps. The modification consists mainly of providing a charging system capable of recharging the pulse forming networks at this increased rate. Presented are the design criteria, the over-all systems modification, the hardware used, and some of the problems encountered in the development of this system. Author (NSA)

N67-18540# Brookhaven National Lab., Upton, N. Y.
DIGITIZED SPARK CHAMBERS AT BNL
Joachim Fischer 1966 17 p refs Presented at the Intern. Conf. on Instrumentation for High Energy Phys., Stanford, Calif., 9–10 Sep. 1966
(Contract AT(30-2)-GEN-16)
(BNL-10576; CONF-660918-1) CFSTI: HC $3.00/MF $0.65

The development of digitized spark chambers at BNL is summarized. Topics discussed are new materials and scattering of printed planes, low mass wire planes, large size printed planes, pulsed electrodes with core read out, planes with 40 conductors/inch, operating characteristics, spatial and time resolution, applications and systems data, and growth trends. NSA

N67-18569# Naval Civil Engineering Lab., Port Hueneme, Calif.
COOLING ANALYSES FOR PROTECTIVE STRUCTURES LOCATED ABOVE AND BELOW GROUND
J. M. Stephenson Nov. 1966 78 p refs
(R-493; AD-642431) CFSTI: HC $3.00/MF $0.65

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N67-18605# Brookhaven National Lab., Upton, N. Y.
THE CRYOGENIC BUBBLE CHAMBER: AN ACCELERATOR RESEARCH FACILITY
J. E. Jensen May 1966 24 p refs Presented at the Am. Soc. of Mech. Engr. Ann. Meeting, New York, 27 Nov.–1 Dec. 1966
(Contract AT(30-2)-GEN-16)
(BNL-10474; CONF-661102-6) CFSTI: HC $3.00/MF $0.65

A description of the 80 inch cryogenic bubble chamber facility at BNL is presented. The operation and research programs are briefly discussed. Future bubble chambers are also described. NSA

N67-18635*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
DESIGN OF A SINGLE AXIS SIMULATOR FOR SATELLITE CONTROL SYSTEM TESTING AND FOR LOW TORQUE MEASUREMENT
Clarence Cantor, John Hrastar, and John Kelly Jan. 1967 56 p refs
(NASA-TM-X-55660; X-732-67-3) CFSTI: HC $3.00/MF $0.65
CSCL 14B

A single-axis simulator design for use in testing satellite control systems and components is described. Two models of the simulator have been built. The first, called a single-axis table, has a large load capacity which is capable of checking most reaction jet-inertia wheel type of control systems, in a torque-free environment (zero torque mode). This model also incorporates a novel, long period oscillation mode for use in checking electro-magnetic dampers used in gravity gradient controlled satellites. The second model, called a microthruster table, is a smaller version of the first for use in checking microthrusters (10^{-6} to 2×10^{-4} lbs) and microthruster control systems, in a vacuum chamber. In addition to the zero torque mode, this model also has a novel, continuous torque mode for continuous "instantaneous" measurement of torque generated by the microthruster under test. Author

N67-18667 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
INSTALLATIONS AND WEIGHTLESSNESS TESTS [INSTALLATIONS ET ESSAIS EN IMPESANTEUR]
M. Delattre *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 12 (See N67-18661 08-34) CFSTI: $3.00

The principle of free fall is analyzed, and the precision of weightlessness simulation tests discussed in this abstracted version of the conference paper. Test facilities conducting free falls in the air and in a vacuum are cited, and problem solutions noted. Two weightlessness simulation installations are currently working on microaccelerometry and the mechanical behavior of liquids in weightlessness. Transl. by R. Li.

N67-18682 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
FILMS ON THE LARGE MODANE-AVRIEUX WIND TUNNEL [FILMS SUR LES GRANDES SOUFFLERIES DE MODANE-AVRIEUX]
In its Sci. Sessions of the O.N.E.R.A. [1966] p 35–38 (See N67-18661 08-34) CFSTI: $3.00

Four films briefly describing the Mondane–Avrieux wind tunnels are reported. Technical details covered include: dynamic stability, propeller tests, firing trials, and aerodynamic characteristics. Transl. by R.Li.

N67-18887 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
EXPERIMENTAL METHODS OF THE DIRECTION AERODYNAMIQUE [MOYENS ET METHODES EXPERIMENTALES DE LA DIRECTION AERODYNAMIQUE]
P. Rebuffet *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 41–45 (See N67-18661 08-34) CFSTI: $3.00

Aerodynamic characteristics of several types of wind tunnels are reported. They are all of small size, not exceeding 3m in diameter in subsonic, 1m transonic, and 0.3 in supersonic and hypersonic speeds. In addition to giving many technical details of the subsonic, transonic and supersonic tunnels, it is stated that these wind tunnels make use of forced oscillation methods. Also described is the Chalais hypersonic tunnel, particularly useful in studying aerodynamic heating, (M = 10), heat flux measurements, and visualizations by heat sensitive tracings. Two hot-shot tunnels are reported to be improved by the arc chamber arrangement. Used in studies of viscous interactions between 50 and 80 km altitude, a R_5 (50 to 400 microbars pressure) tunnel is also detailed technically. Transl. by R.Ll.

N67-18698*# United Aircraft Corp., Farmington, Conn. Corporate Systems Center.
STUDY OF CELESTIAL/INERTIAL TEST FACILITY Final Report
G. Sonneman and L. Manoni 31 Oct. 1966 62 p refs
(Contract NAS12-108)
(NASA-CR-80007; SCR-295) CFSTI: HC $3.00/MF $0.65 CSCL 14B

The equipment necessary to provide a ground based testing capability for the evaluation and qualification of current and future optical sensors employed in celestial navigation and guidance systems were identified, and the technical requirements associated with the equipment as they would influence laboratory building design were determined. The observables considered are the Sun, the Earth, the Moon, Jupiter, Venus, Mars, and stars of +3 visual magnitude, and summaries of the pertinent characteristics of each are presented. The parameters associated with simulation and the desired tolerances are specified for each observable. The physical requirements and the space allotments for the facility's buildings are described. These include (1) the low-rise building housing the optical test facility, and (2) the high-rise housing the celestial test facility and the inertial test facility. The requirements for the integration of the two buildings is covered. N.E.N.

N67-18753*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
MOBILE AEROBEE LAUNCH FACILITY
Jon R. Busse Nov. 1966 12 p ref
(NASA-TM-X-55694; X-724-66-539) CFSTI: HC $3.00/MF $0.65 CSCL 22D

Pertinent details are provided describing the establishment of the Mobile Aerobee Launch Facility (MALF), a completely portable facility including: 50 foot length launch tower, propellant servicing system, helium pressurization system, launch control console, and rocket handling and loading equipment. MALF was designed and built to permit increased selectivity of launch location for scientists launching space science payloads to observe spatial phenomena only observable from particular geographic locations (solar eclipses, magnetic and other spatial anomalies, southern hemisphere stellar objects, etc.). All aspects of design, construction, assembly, and operation of the portable liquid rocket launching facility, including data on dispersion and wind weighting, methods for analyzing liquid propellants, and packaging and storing techniques, are discussed. Information is provided regarding procedures required for emplacing and operating the facility, and the sequency of events for conducting the first launch operation for the facility in Natal, Brazil (4th quarter 1966). In addition, future simplifications planned for the facility are outlined. Such discussions include the Rail Aerobee Launch Facility (RALF), a concept which proposes launching an Aerobee Sounding Rocket from a thirty-foot length rail mounted on a Nike–Ajax military launcher. Author

N67-18951*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
STATIC CALIBRATION OF AN EJECTOR UNIT FOR SIMULATION OF JET ENGINES IN SMALL-SCALE WIND-TUNNEL MODELS
Richard J. Margason and Garl L. Gentry Washington, NASA, Mar. 1967 29 p refs
(NASA-TN-D-3867) CFSTI: HC $3.00/MF CSCL 14B

This report describes an ejector that was developed to simulate performance characteristics of a jet engine in small-scale wind-tunnel models. The thrust produced by of the simulator and the secondary (inlet) mass flow were calibrated statically as a function of the total- and static-pressure measurements inside the ejector nozzle. The thrust can be repeated within 1 percent for a given set of pressure measurements. Deflections of the exit up to 30° changed only the angle of the resultant thrust. The ratio of the thrust to secondary (inlet) mass flow was used as a scale factor for the static simulation of jet-engine performance. This scale factor can be changed either by changing the level of thrust (varying the primary line pressure) or by changing the nozzle exit area. Wind-tunnel models that use these ejectors should have levels of jet-induced lift loss which are comparable to those caused by a jet engine. Author

N67-18972*# Naval School of Aviation Medicine, Pensacola, Fla.
THE CORIOLIS ACCELERATION PLATFORM: A UNIQUE VESTIBULAR RESEARCH DEVICE
W. Carroll Hixson and John J. Anderson 1 Oct. 1966 35 p refs
(NASA Order R-93; Proj. MR005.04.002V)
(NASA-CR-82403; NAMI-980) CFSTI: HC $3.00/MF $0.65 CSCL 14B

The report presents a brief description of the Coriolis Acceleration Platform, a new combined linear and angular motion-producing vestibular research device developed to study the biological effects of aerospace acceleration environments. The primary element of the device is a 20-ft diameter capsule equipped with various life-support equipments to study the long-term effects of continuous rotation. A low rpm, direct-coupled, DC torque motor operated in a closed-loop, velocity mode, power servomechanism configuration rotates the device about an Earth-vertical axis in either direction at angular velocities extending to 200 deg/sec at accelerations ranging to 15 deg/sec^2. A second drive system can be programmed to produce time-varying rectilinear translations of a single subject along a track structure fixed to the capsule where this form of motion can occur singly, or in combination with rotation of the entire device. Peak ratings of the linear drive system include a radial displacement of ±20 ft, a linear velocity of ±16 ft/sec, and a linear acceleration of 96 ft/sec^2 (3g). Author

N67-19148# Marine Engineering Lab., Annapolis, Md.
DEVELOPMENT OF A STEAM-POWERED, FREE-PISTON AIR COMPRESSOR, PHASE II
Stephen H. Ford and Robert M. Fox Sep. 1966 27 p refs
(MEL-150/66; AD-638171) CFSTI: HC $3.00/MF $0.65

Development of a steam-driven, free-piston air compressor is described. A single-piston version of the unit has been designed and constructed. Preliminary test operation has shown the feasibility of the concept. A computer program has been developed as an

aid in studying the performance characteristics and design aspects of the compressor. Correlation of the computer program with the compressor operation has been established. Author (TAB)

N67-19239# Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex. Dept. of Aerosol Physics.
PREPARATION OF INSOLUBLE AEROSOLS CONTAINING MIXED FISSION PRODUCTS
S. Posner and J. Bennick Jul. 1966 14 p refs Presented at the Ann. Conf. of Am. Ind. Hyg. Assoc., Pittsburgh
(Contract AT(29-1)-1013)
(LF-31; CONF-660504-3) CFSTI: HC $3.00/MF $0.65

The preparation of an insoluble aerosol containing mixed fission products, using an ion exchange of uranyl nitrate with montmorillonite clay, is described. Ion exchange of an enriched solution of uranyl nitrate to clay particles is accomplished by adsorption. After spheroidizing by encapsulation the exchanged material is sealed in a quartz vial and irradiated for 12 hours in a thermal column of the Omega West Reactor at Los Alamos, New Mexico. Evaluation by gamma ray spectroscopy reveals the quantitative fission product inventory for the exposure period; calculation indicated an approximate 26% uptake of uranyl ions by the clay. Results indicate this method to be feasible and practicable and future studies will include evaluation of particle size versus ion uptake, fission product build-up for various exposure times, and pilot runs of aerosolization for exposure to animals. Author (NSA)

N67-19336# Argonne National Lab., Ill.
MEETING ON THE DESIGN OF LARGE SUPERCONDUCTING BUBBLE CHAMBER MAGNETS
C. Laverick, ed. Mar. 1966 57 p refs Meeting held at Argonne Natl. Lab., Ill., 18 Nov. 1965
(Contract W-31-109-ENG-38)
(ANL-7192) CFSTI: HC $3.00/MF $0.65

The design of very large supermagnets with stored energies of the order of 10^7 J and above is considered. The design programs discussed include the general programs of ANL and BNL, the ANL superconducting bubble chamber magnet, the BNL superconducting magnet, the Stanford linear accelerator center studies, and the Livermore magnet program. NSA

12 FLUID MECHANICS

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion.

N67-18241 Lockheed Missiles and Space Co., Palo Alto, Calif.
SOME PROBLEMS ON THE NON-ISOTHERMAL STATIONARY FLOW OF A NON-NEWTONIAN FLUID
S. A. Bostandzhian and S. M. Chernieeva [1966] 6 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Mekh. Zhidk. i Gaza (Moscow), no. 3, 1966 p 85–89

The flow of a nonnewtonian fluid between two parallel planes, a headless axial flow in an annular gap, and the flow between two rotating cylinders in the presence of dissociation are investigated. The rheological equation, $\tau = k(dv/dy)^n$, is used in which τ is the tangential stress; dv/dy is the velocity gradient; and k and n are quantities dependent on the temperature in the general case. Because of the weak dependence of the exponent n on the temperature, it is assumed that n is temperature independent, and the temperature dependence of k is given as $k = k_0 e^{-\beta T}$. C.T.C.

N67-18262# Aeronautical Research Council (Gt. Brit.).
BOUNDARY-LAYER SEPARATION IN SUPERSONIC PROPELLING NOZZLES
M. V. Herbert and R. J. Herd London, HMSO, 1966 87 p refs Supersedes NGTE-R-260; ARC-26102; see X65-18811
(ARC-R&M-3421; NGTE-R-260; ARC-26102; AD-803250) CFSTI: HC $3.00/MF $0.65

A comparison has been made between the pressure rise at separation in convergent–divergent nozzles and that in other models with supersonic flow and a turbulent boundary layer. In the case of nozzles with uniform divergence, close similarity is found to the characteristics of separation induced on surfaces with initially zero pressure gradient. Where exceptions to this general agreement occur, three special categories of nozzle data can be distinguished. The first, involving a change of behavior in the vicinity of separation, is attributable to the existence of a laminar boundary layer or of one in a state of transition. A critical value of Reynolds number at separation, based on equivalent flat-plate length, is found to be around 0.7 million. The second form of abnormality corresponds to an unusually large amount of pressure rise in the region between separation and nozzle outlet; this can occur in nozzles of low divergence angle with either turbulent or laminar separation, the effect being most pronounced with the latter. Third comes the case of a shock system in close proximity to nozzle outlet, where the full interaction pressure rise with a turbulent boundary layer is unable to develop. Author (TAB)

N67-18265# Aeronautical Research Council (Gt. Brit.)
CALCULATIONS OF THE STRUCTURE OF UNSTEADY RAREFACTION WAVES IN OXYGEN/ARGON MIXTURES, ALLOWING FOR VIBRATIONAL RELAXATION
J. P. Appleton London, HMSO, 1966 33 p refs Supersedes RAE-TN-AERO-2873; ARC-24933; see N65-20509
(ARC-CP-720; RAE-TN-AERO-2873; ARC-24933) CFSTI: HC $3.00/MF $0.65

Numerical computations were performed to investigate the effect of molecular vibrational relaxation on the structure of one-dimensional unsteady rarefaction waves in oxygen and oxygen–argon mixtures. A nonequilibrium flow feature illustrated by the results of the relaxation equation is that the vibrational temperature of gas which enters an aging wave will first decrease, closely following the translational temperature, until at some position within the wave it will depart rapidly from the translational temperature and eventually freeze at a constant value. Author

N67-18268# Aeronautical Research Council (Gt. Brit.)
A VELOCITY DEFECT RELATIONSHIP FOR THE OUTER PART OF EQUILIBRIUM AND NEAR EQUILIBRIUM TURBULENT BOUNDARY LAYERS
J. McQuaid (Cambridge Univ.) London, HMSO, 1966 37 p refs Supersedes ARC-27287; see X68-15174
(ARC-CP-885; ARC-27287) CFSTI: HC $3.00/MF $0.65

It is shown that the outer part of the velocity defect profiles for equilibrium turbulent boundary layers on solid surfaces can be satisfactorily reduced to an almost universal curve by the use of the velocity scale $U_* = U_e(d\theta/dx)^{1/2}$, with $d\theta/dx$ obtained from the momentum integral equation. The procedure thus uses a single scale for the complete range of the pressure gradient parameter π, whereas previously the use of U_τ as in Clauser's formulation is restricted to cases of finite wall shear stress. The present scale reduces to U_τ as required for the constant pressure layer and is simply related to U_p for the zero wall stress layer. The scale is

also found to account for the outer part of near-equilibrium layers, in particular for the constant pressure layer with uniformly distributed injection. Finally, by combining the relationship with the two-parameter family of mean velocity profiles of Thompson, a simple method is obtained for calculating the variation of the shape parameter. Author

N67-18336*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
VISCOUS AND INVISCID AMPLIFICATION RATES OF TWO-DIMENSIONAL AND THREE-DIMENSIONAL LINEAR DISTURBANCES IN THE LAMINAR COMPRESSIBLE BOUNDARY LAYER
L. M. Mack *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 158–162 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

The parallel flow theory is used to study the stability characteristics of three-dimensional disturbances at low Mach numbers. The inviscid theory calculations were extended from $M_1=4.5$ down to 1.6; the results are plotted to show the maximum time rate of amplification (for any wave number or any angle) as a function of Mach number for both two- and three-dimensional first mode disturbances. It is seen that the ratio of three-dimensional to two-dimensional amplification rates becomes quite large at low Mach numbers. The viscous first mode maximum amplification rates versus Mach number for two- and three-dimensional disturbances were also graphed. Results obtained at finite Reynolds numbers show that the two-dimensional disturbance is the most unstable up to about $M_1=1$. For higher Mach numbers, the three-dimensional disturbances are the most unstable, with the action of viscosity up to at least $M_1=2.2$ plainly destabilizing as for two-dimensional disturbances. Further, the amplification rate at $M_1=2.2$ of the most unstable three-dimensional disturbance is within range of the experimental results. M.G.J.

N67-18377# National Aero- and Astronautical Research Inst., Amsterdam (Netherlands). National Aerospace Lab.
A METHOD FOR ESTIMATING UNSTEADY PRESSURE DISTRIBUTIONS FOR ARBITRARY VIBRATION MODES FROM THEORY AND FROM MEASURED DISTRIBUTIONS FOR ONE SINGLE MODE
H. Bergh and R. J. Zwaan Feb. 1966 18 p refs Submitted for Publication Prepared for Neth. Aircraft Develop. Board (NLR-TR-F-250) CFSTI: HC $3.00/MF $0.65

A method is proposed to estimate for a lifting surface pressure distributions to be measured for arbitrary vibration modes by the aid of theory and measured distributions for one single mode. Its usefulness is demonstrated on hand of two swept wings of small aspect ratio oscillating in incompressible flow. Author (ESRO)

N67-18401*# National Aeronautics and Space Administration, Washington, D. C.
FORCED DISCONTINUOUS OSCILLATIONS OF A FLUID IN A PIPELINE
M. S. Natanzon Feb. 1967 20 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Ser. Mekhan. (Moscow), no. 2, 1965 p 33–42
(NASA-TT-F-443) CFSTI: HC $3.00/MF $0.65 CSCL 20D

Described is the development of obtaining asymptotic solutions of the problem of forced discontinuous cavitational oscillations of a fluid in a pipeline. It is shown that using these solutions it is possible to analyze the basic characteristics of discontinuous cavitational oscillation in the absence of energy dissipation, as well as to study the modes of discontinuous oscillations taking energy dissipation into account. Author

N67-18481# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PROCEEDINGS OF THE GROUP SCIENTIFIC AND TECHNICAL CONFERENCE ON PROBLEMS OF FLUID MECHANICS [DOKLADY KUSTOVOY NAUCHNO-TEKHNICHESKOY KONFERENTSII PO VOPROSAM MEKHANIKI ZHIDKOSTI I GAZA]
13 Oct. 1966 81 p refs Transl. into ENGLISH from Tr. Kuybyshevskiy Aviats. Inst. (Kuybyshev), v. 15, pt. 2, 1963 p 106–156; p 299–307 Conf. held in Kuybyshev, USSR 1963 (FTD-TT-65-1366; TT-67-60203; AD-643643) CFSTI: HC $3.00/MF $0.65

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N67-18485# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SOME RESULTS OF WIND TUNNEL TESTS OF PLANE DIFFUSER CASCADES WITH LOW RATES OF FLOW
In its Proc. of the Group Sci. and Tech. Conf. on Probl. of Fluid Mech. 13 Oct. 1966 p 32–43 refs (See N67-18481 08-12) CFSTI: HC $3.00/MF $0.65

A critical evaluation of the method of testing Howell cascades is made by analyzing results of low flow rate wind tunnel tests of plane cascades. Experimental dependances of cascade flow parameters on the cascade geometry is included. The method suggested by Howell is associated with a considerable uncertainty in the choice of the profile curvature angle and the angle of attack for a given stress deflection; and the stream deflections given by Howell for sparse cascades are found to be too high. A series of curves are constructed that depict flow parameters as functions of the cascade geometry and are free from these disadvantages. M.W.R.

N67-18486# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
RESULTS FROM AN EXPERIMENTAL INVESTIGATION OF A DIFFUSER WITH ADDITIONAL FLOW PRESSURE AT THE OUTLET

G. M. Gorelov and A. S. Freydin *In its* Proc. of the Group Sci. and Tech. Conf. on Probl. of Fluid Mech. 13 Oct. 1966 p 44–51 refs (See N67-18481 08-12) CFSTI: HC$3.00/MF$0.65

Common hydraulic characteristics of several in-line diffusers with large outlet angles were investigated in a plane wind tunnel, as was a channel with sudden cross section expansion and constant resistance from a tube array mounted in a plane channel to produce additional flow pressure behind the channel. Losses in resistance increase as the resistance is brought closer to the channel outlet because of the large inflow angles with respect to the grid tubes at the channel walls. Results obtained by testing diffusers with efflux additional flow pressure indicate that hydraulic losses are independent of changes in distance to the resistance. Reduction of stagnation zone dimensions, resulting from reduction in distance between inlet to the diverging channel and resistance behind it, do not give rise to a change in hydraulic losses. Losses that occur when the stagnation zone reduction is due to the reduction of diffuser spread angle with unchanged resistance are attributed to change in diffuser geometry shape that disrupts the hydrodynamic similarity of the vortex system. M.W.R.

N67-18487# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

COEFFICIENTS OF HEAT TRANSFER AND HYDRAULIC RESISTANCE AS FUNCTIONS OF LONGITUDINAL AND TRANSVERSE NONISOTHERMICITY IN TURBULENT MOTION OF FLUID UNDER INTERNAL-PROBLEM CONDITIONS

V. K. Lyakhov *In its* Proc. of the Group Sci. and Tech. Conf. on Probl. of Fluid Mech. 13 Oct. 1966 p 52–59 refs (See N67-18481 08-12) CFSTI: HC$3.00/MF$0.65

A modification is presented for an approximate theoretical solution to the problem of turbulent motion of a fluid with variable values for the physical parameters; and a relationship is established between the method of characteristic temperatures and the method of correction factors. A simplified system of differential equations is used to formulate the mathematical problem; and it is assumed that the variability of the physical parameters is mutually independent, and viscosity varies in such a way that there is no difference in the thickness of the thermal and hydrodynamic layers. A theoretically substantiated value is obtained for the correction factor on the influence of nonisothermicity with drop liquids and with air; and this solution explains why generalized expressions for the correction factors for the coefficients of resistance and heat transfer agree with heat exchange in air and differ for drop liquids. M.W.R.

N67-18513 Joint Publications Research Service, Washington, D. C.

EXPERIMENTAL HIGH-SPEED PHOTOGRAPHIC INVESTIGATION OF THE MOTION OF A SINGLE CAVITATION BUBBLE

Te-Chun Chang and Ch'eng-Hao Wang *In its* Transl. on Communist China's Sci. and Technol., No. 356 20 Dec. 1966 p 16–28 refs (See N67-18511 08-34) CFSTI: $3.00

Experimental results in regard to the growth–collapse motion of a single bubble basically coincide with the theoretical deductions. In studying the instant of collapse of the cavitation bubble, the phenomenon of small pulsation has been discovered; this provides significant evidence for the hypothesis that a micro shock wave may be produced within the cavitation bubble at the instant of collapse. The experiments are used to study the growth and collapse of the cavitation bubble and the attenuation of rebound motion. Author

N67-18522# Aktiebolaget Atomenergi, Stockholm (Sweden).

ON SHEAR STRESS DISTRIBUTIONS FOR FLOW IN SMOOTH OR PARTIALLY ROUGH ANNULI

B. Kjellstroem and S. Hedberg Aug. 1966 70 p refs (AE-243)

It is commonly assumed that for turbulent flow in annuli the radii of zero shear and maximum velocity are coincident. By inspection of the differential equations for such flow and by an integral analysis it is shown that this is not necessarily true. To check whether important differences could occur, experiments were made in which velocity and shear stress distributions were measured in one smooth and two partially rough annuli. The results show no difference in the radii for the smooth annulus, but for the partially rough annuli there was a small but significant difference. This difference explains the breakdown of Hall's transformation theory reported by other investigators. The error introduced by use of Hall's theory, however, is small, of the order of 10% or less. Author (NSA)

N67-18554

INFLUENCE OF SOLUTIONS OF SOME HIGH-MOLECULAR COMPOUNDS ON DRAG REDUCTION IN TURBULENT FLOW AROUND BODIES

G. I. Barenblatt, I. G. Bulina, and V. P. Miasnikov 1965 3 p refs Transl. into ENGLISH from Prikl. Mekh. i Tekhn. Fiz. (USSR), no. 3, 1965 p 95–96

The effects of the introduction of polymer solutions in a turbulent flow on the drag of a circular cylinder were investigated. The drag was determined for the stand, for the stand and cylinder, and for the stand, cylinder, and polymer solution. A reduction of 20–34% in drag with a turbulent flow of Reynolds number $\approx 6.5 \times 10^4$ was noted. It was also found that the higher the escape velocity of the polymer at the exit from the body, the smaller the drag reduction. Possible mechanisms for the drag reduction are listed. N.E.N.

N67-18559 Lockheed Missiles and Space Co., Palo Alto, Calif.

THREE DIMENSIONAL FLOW AROUND BLUNT CONES

A. I. Shvets [1966] 6 p refs Transl. into ENGLISH from Vestn. Mosk. Univ., Ser. I: Mat. i Mekhan. (Moscow), no. 6, 1966 p 85–89

Experimental results on the supersonic flow around blunt bodies with a detached shock are compared with computed results. Aerodynamic characteristics, force coefficients, shape of the shock, and stand-off distance are analyzed and presented in graphical representations. It is noted that the flow around the bluntness determines the flow picture at a downstream distance of several nose-section diameters for cones with small half-angles. The gas particles moving along the initial portion of the conical surface pass through an intense shock which is formed ahead of the bluntness, and the gas particles intersecting the bow wave at sufficiently great distances pass through a wave corresponding to the flow around a pointed cone. Consequently, at large distances from the nose, near the surface a so-called entropy layer with high transverse entropy gradient appears with a corresponding density and velocity component tangential to the surface. A.G.O.

N67-18665*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

RADIAL STATIC PRESSURE DISTRIBUTIONS IN CONFINED COMPRESSIBLE VORTEX FLOW FIELDS

Thomas J. Pivirotto 1 Mar. 1967 30 p refs (Contract NAS7-100) (NASA-CR-82155; JPL-TR-32-1076) CFSTI: HC $3.00/MF $0.65 CSCL 20D

A confined vortex flow was studied to determine the effect of the fluid mass flow rate and the exit orifice diameter on the radial static-pressure distribution for a given vortex tube diameter, length, and injection configuration. The exit hole diameter had a significant effect on the radial pressure distribution, and the mass

flow rate lost its influence on the pressure distribution beyond a limiting value, which increased with increasing exit hole diameter. From 50 to 90% of the fluid momentum was lost at the cylindrical wall. A method was also developed for determining the effective radial Reynolds number and effective exit hole radius from the experimentally determined maximum tangential Mach number and its radial location. Author

N67-18889*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
MECHANISM OF STEAM BUBBLE FORMATION
I. G. Shekriladze Jan. 1967 18 p refs Transl. into ENGLISH from Soobshcheniya Akad. Nauk Gruzin. SSR (Tiflis), v. 41, no. 2, 1966 p 391–398 Jointly supported by Army Missile Command
(NASA-TM-X-59398; RSIC-632) CFSTI: HC $3.00/MF $0.65 CSCL 20D

Discussed are the results of a theoretical study which revealed the determining role of a phase change on the surface of the steam bubble that originated on the heating wall in the hydrodynamics of the process of steam bubble formation. The new physical model of the process, built on the basis of the results of this study, which differs essentially from those known, makes it possible to explain the basic experimental facts that characterize the process of steam bubble formation. Author

N67-18885 France. Office National D'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
RESEARCH ON DETACHED FLOWS [RECHERCHES SUR LES ECOULEMENTS DECOLLES]
M. Siriex *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 41–42 (See N67-18861 08-34) CFSTI: $3.00

As a basis for studying the hypersonic slipstream, a theory on separated flow is advanced. General solutions for the following types of problems are discussed: (1) determination of flow conditions in a laminar or turbulent boundary layer; (2) definition of the turbulent or laminar mixing laws before the separation; and (3) the analysis of reattachment of a free flow on an obstacle, or the intermingling of initially free fluid sheets. The mathematical expressions are derived, and the solution extended to a second category of problems; the dynamic study of isobaric mixing was extended to the case of heat and mass transfers. Transl. by R.Ll.

N67-18901 Lockheed Missiles and Space Co., Palo Alto, Calif.
ON THE ANALYSIS OF THE BASE PRESSURE IN TWO-DIMENSIONAL SUPERSONIC FLOWS
L. V. Gogish and G. Iu. Stepanov [1966] 9 p refs Transl. into ENGLISH from Mekh. Zhidkosti i Gaza (USSR), no. 3, 1966 p 109–114

The method of straight line characteristics using a given separated flow hodograph is used for an approximate analysis of the supersonic two-dimensional isentropic flow. Dissipative flow is taken into account by a universal function, the admissible angle of layer rotation in the domain of flow compression. It is shown by examples of determining the base pressure on cylinder endfaces (2°), as well as on the endface surfaces of a plane channel (3°), and in a nozzle with an angular point (4°) that the results of the computations agree satisfactorily with experiment. Author

N67-18902* Lockheed Missiles and Space Co., Palo Alto, Calif.
SOME QUESTIONS OF FINITE-AMPLITUDE WAVE PROPAGATION IN A FLUID
A. A. Tuzhilin [1966] 4 p refs Transl. into ENGLISH from Tr. Mosk. Fiz.-Tekhn. Inst. (Moscow), no. 5, 1960 p 73–77

Consideration is given to the influence of sound source displacement on the propagation law of the finite amplitude waves in an ideal fluid. Some fundamental relationships are presented and compared for finite amplitude waves produced by both a fixed surface on which the velocity of medium motion is given, and by an oscillating surface. Author

N67-18904# Lockheed Missiles and Space Co., Palo Alto, Calif.
ON A NEW METHOD OF THE NUMERICAL SOLUTION OF NONSTATIONARY GASDYNAMICS PROBLEMS WITH TWO SPACE VARIABLES
V. F. D'Iachenko [1966] 10 p refs Transl. into ENGLISH from Vychisl. Mat. i Mat. Fiz. (USSR), v. 5, no. 4, 1965 p 680–688

The use of Lagrange coordinates without a fixed coordinate mesh is proposed as a solution to those problems in which strong distortions of the mesh may be expected. The values of the functions are evaluated at points connected with fixed masses of gas, the gas particles. However, if the particles which have Lagrange coordinates close together are customarily used for this calculation in the difference scheme, then particles placed close to each other in space at a given instant are used. The method described uses the partial differential equations of gas dynamics to solve problems with two space variables. Integral formulas are derived; also considered is a technique for evaluating the integrals if the values of the functions are known only at a discrete and arbitary set of points. The complete system of difference relations is obtained. The principle involved in selecting close points is discussed. To solve problems with shocks, the method is supplemented by introducing an artificial viscosity, which eliminates the discontinuity, into the difference scheme. An example of the computation is included. M.G.J.

N67-18905 Lockheed Missiles and Space Co., Palo Alto, Calif.
ON THE INSTABILITY OF PARALLEL VISCOUS INCOMPRESSIBLE FLUID FLOWS RELATIVE TO SPATIALLY PERIODIC PERTURBATIONS
V. I. Iudovich [1966] 9 p refs Transl. into ENGLISH from Russian

Parallel flows and their stability relative to perturbations periodic in x,y with periods $2\pi/\alpha_0$, 2π are considered. In formulating the problem, initial data for the two-dimensional Navier–Stokes equation are used. It is shown that for sufficiently large values of the Reynolds number and small α the stability is lost. The method of proof is asympotic integration of the Orr–Sommerfeld equations for long wavelength perturbations. Two versions are presented: in one the asympototic of the critical Reynolds number is found; in the other, the asymptotic of the eigenvalue. An upper bound is obtained for the absolute Reynolds number (minimum in the perturbation period), which becomes an equality in the case of the flow considered. The fundamental result is given along with a foundation for the asymptotic. It is pointed out that the method extends to two- and three-dimensional spatially periodic flows. M.G.J.

N67-18906 Lockheed Missiles and Space Co., Palo Alto, Calif.
ON THE QUESTION OF A METHOD OF SOLVING AERODYNAMIC PROBLEMS OF A SLIGHTLY RAREFIED GAS
V. A. Tsiberov [1966] 10 p refs Transl. into ENGLISH from Vestn. Leningr. Univ., no. 13, 1966 p 91–100

A refined method is described which permits parameters characterizing a slightly rarefield viscous gas to be found easily without integrating the macroscopic gas motion equations. The gas parameters should deviate little from the limiting values. Small additions to the gas density, temperature, and microscopic velocity in the boundary layer are calculated by means of the Burnett functions. R.N.A.

N67-18923*# National Aeronautics and Space Administration, Washington, D. C.
SUPERSONIC FLOW AROUND BLUNT BODIES OF REVOLUTION WITH A GENERATRIX DISCONTINUITY [SVERKHZVUKOVOYE OBTEKANIYE ZATUPLENNYKH TEL VRASHCHENIYA S IZLOMOM OBRAZUYUSHCHEY]
O. M. Belotserkovskiy, Ye. S. Sedova, and R. V. Shugayev Feb. 1967 8 p refs Transl. into ENGLISH from Zh. Vychislitel'noi Mat. i Mat. Fiz. (Moscow), v. 6, no. 5, 1966 p 930–934
(NASA-TT-F-10625) CFSTI: HC $3.00/MF $0.65 CSCL 01A

The integral method of Vaglio–Laurin is used to solve the supersonic flow problem around spherical segments. It is shown that second and third order terms are unimportant. Author

N67-18924*# National Aeronautics and Space Administration, Washington, D. C.
CALCULATION OF THE BASE PRESSURE IN TWO-DIMENSIONAL SUPERSONIC FLOWS [KRASCHETU DONNOGO DAVLENIYA V DVUKHMERNYKH SVERKHZVUKOVYKH TECHENIYAKH]
L. V. Gogish and G. Yu. Stepanov Jan. 1967 10 p refs Transl. into ENGLISH from Izv. Akad. Nauk. SSSR, Mekhan. Zhidkosti i Gaza (USSR), no. 3, May–Jun. 1966 p 109–114
(NASA-TT-F-10659) CFSTI: HC $3.00/MF $0.65 CSCL 20D

A method for determining the base pressure in complex two-dimensional supersonic flows is described. A two-dimensional isentropic supersonic flow is calculated in approximation, by the method of linear characteristics using a given separation-flow hodograph. Experimental and calculated results for the base pressure on a cylinder end, on the end bases of a plane channel, and in a nozzle are in fair agreement. An analysis of the dependence of the base pressure on the characteristics of a separation flow is conducted, using an engineering formula. Author

N67-18934*# National Aeronautics and Space Administration, Washington, D. C.
FREE-MOLECULAR GAS FLOW IN PLANE CHANNELS AND GRIDS [SVOBODNO-MOLEKULYARNOYE TECHENIYE GAZA V PLOSKIKH KANALAKH I RESHETKAKH]
A. I. Bunimovich and M. L. Kagan Jan. 1967 6 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Mekh. Zhidkosti i Gaza (Moscow), no. 3, 1966 p 129–131
(NASA-TT-F-10692) CFSTI: HC $3.00/MF $0.65 CSCL 20D

The problem of the free-molecular flow of a rarefied gas in plane channels or through the cells of a grid is discussed, assuming that the grid cells and the overall geometric dimensions of the grid are less than the mean free path of gas molecules and that the grid material is ideally heat conducting. The probability of the passage of gas molecules is calculated and the aerodynamic parameters of the grid are determined for the case of diffusive reflection of gas molecules from a grid or channel. Author

N67-18986*# Florida State Univ., Tallahassee. Dept. of Statistics.
ASYMPTOTIC EFFICIENCY OF TWO NONPARAMETRIC COMPETITORS OF WILCOXON'S TWO SAMPLE TEST
Myles Hollander 1 Feb. 1967 21 p refs
(Grant NGR-10-004-029)
(NASA-CR-82468; TR-12) CFSTI: HC $3.00/MF $0.65 CSCL 12A

Wilcoxon's signed rank test and a test based on the uniform minimum variance unbiased estimator of $P(X_1+X_2<Y_1+Y_2)$ are considered as competitors of the Mann-Whitney-Wilcoxon (U) test. The criteria used to compare the tests are Bahadur and Pitman efficiency. For pure translation alternatives U is superior, but both tests compare favorably with respect to U for certain contamination alternatives. Author

N67-19021*# National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.
CRITERION FOR MASS DROP-OFF MEASUREMENTS BASED UPON PRECISE PRESSURE AND TEMPERATURE MEASUREMENTS
Jan H. Sodergren (SPACO, Inc.) 9 Dec. 1966 36 p refs
(NASA-TM-X-53551) CFSTI: HC $3.00/MF $0.65 CSCL 20D

An analytical study was performed to determine if mass drop-off measurements, based upon precise temperature and pressure measurements, could be used successfully for the detection of leaks in complex gas systems on space vehicles. Leaks under isothermal as well as isobaric conditions were investigated using both the perfect gas law and the virial expansion for the compressibility factors. This study showed that the mass drop-off method is very limited in scope due primarily to the requirement of the temperature measurement. Author

N67-19055*# General Applied Science Labs., Inc., Westbury, N. Y.
MIXING IN SUPERSONIC FLOW
J. H. Morgenthaler Sep. 1966 62 p refs
(Contract NAS8-20066; Proj. 8027)
(NASA-CR-82526; GASL-TR-592) CFSTI: HC $3.00/MF $0.65 CSCL 20D

A method was presented for the determination of turbulent transport coefficients in multicomponent flows which requires a single differentiation of experimental $\overline{Y}$, $\overline{V}_x$, $\overline{H}$, and $\overline{\rho}$ data. Assumptions which allow simplification of the general equations of change, i.e., continuity, diffusion, momentum, and energy equations, were discussed. A constant stagnation temperature was shown to be a particular solution of the energy equation when Le_T and Pr_T (and hence Sc_T) are unity. Limitations of the method were investigated using a test case, in which assumed values of the transport coefficients were used to generate down stream $\overline{Y}$ and $\overline{V}_x$ profiles, and these computed profiles were used in an attempt to reproduce the originally assumed transport coefficients. This technique allowed direct comparison of derived coefficients with the input values. Results of these comparisons showed the spacing of the data points to be critical parameter, but that interpolated values could be used in conjunction with original data points (if properly smoothed). Author

N67-19077*# New York Univ., N. Y. School of Engineering and Science.
AN INVESTIGATION OF APPROXIMATE SOLUTIONS TO FLUID DYNAMICS AND HEAT TRANSFER PROBLEMS BY VARIATIONAL METHODS
Wheeler K. Mueller and Stanley T. Liu Dec. 1966 44 p refs
(Grant NGR-33-016-067)
(NASA-CR-82501; F-66-1) CFSTI: HC $3.00/MF $0.65 CSCL 20D

Approximate solutions using a variational method were investigated for fluid dynamics and thermal problems. The application of the variational technique, based on a least squares procedure suggested by Citron, is illustrated by solutions for a melting–freezing problem, a natural convection problem, and two transient heat condition problems. Comparison with exact solutions was made to determine the degree of accuracy of the approximation method. Author

N67-19084*# Massachusetts Inst. of Tech., Cambridge. Dept. of Electrical Engineering.
ELECTROMECHANICAL STREAM-STRUCTURE INSTABILITIES
Frederick D. Ketterer Aug. 1966 42 p refs
(Grant NsG-368)
(NASA-CR-82515; CSR-TR-66-16) CFSTI: HC $3.00/MF $0.65 CSCL 20K

The problem of a highly conducting fluid stream coupled by means of a transverse electric or parallel magnetic field to a conducting elastic medium is examined in detail. From the dispersion relation and the Bers–Briggs criterion the stability of the infinite length system is described. Eigenfrequencies and eigenfunctions are computed for the finite length system and good agreement is obtained with experiments performed with an electrohydrodynamic system. A physical explanation is given for the overstabilities observed. The close analogy between a limiting case of the field coupled system and an electron beam coupled to a traveling wave structure is discussed. Author

N67-19115* Tennessee Univ., Knoxville. Dept. of Engineering Mechanics.
NUMERICAL AND EXPERIMENTAL INVESTIGATION OF A TWO-DIMENSIONAL LAMINAR FLOW WITH NON-REGULAR BOUNDARIES
Eduardo José Tejeira (Ph.D. Thesis) Aug. 1966 243 p refs
(Grant NGR-43-001-021)
(NASA-CR-82655; EM-66-8-1) CFSTI: $3.00 CSCL 20D

The numerical solution of the complete, incompressible, steady state, Navier–Stokes equations obtained for a two-dimensional channel with a diverging section, is described. An experimental verification of the results for low Reynolds numbers by means of birefringence measurements is also presented. The outstanding aspect of the numerical solution is that the flow field mesh points do not coincide with the boundary of the diverging section. Finite difference equivalents for points on or adjacent to such a boundary were derived by means of Taylor expansions in two position variables. Numerical analysis of the convergence and rate of convergence of the over- and under-relaxed Gauss–Seidel iteration for the steady state problem over a square field showed the technique to lead to convergence regardless of the value of the Reynolds number. The same type of analysis when applied to the unsteady state problem resulted in the rate of convergence being very fast at all Reynolds numbers. The maximum strain rate contours obtained from the numerical solution agreed with experimental values. Specifically, 95% of the measured values fell within 4% of the numerical values. Author

N67-19131* New York Univ., N. Y. Research Div.
INCOMPRESSIBLE BOUNDARY LAYERS WITH CONSTANT WALL SHEAR AND ARBITRARY INITIAL SHEAR PROFILES
Jack Werner Jan. 1967 30 p refs
(Grant NGR-33-016-067)
(NASA-CR-82448; F-67-1) CFSTI: HC $3.00 CSCL 20D

The problem of determining the pressure gradient required to maintain a specified wall shear in a boundary layer for a given initial shear profile is treated by solving the Crocco equation. It is found that analytic solutions are readily obtainable when the problem is restricted to the case of continuous wall shear. To illustrate the method the case of constant wall shear has been treated for initial profiles obtained from suction and injection over a flat plate, assuming that the suction or injection is terminated at the station of the initial profile. Both the pressure gradient and the downstream shear profile has been computed in each case. Author

N67-19159# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Munich (West Germany).
THE GENERATION OF UNIFORM-SIZED LIQUID DROPLETS [DIE ERZEUGUNG VON FLUESSIGKEITSTROEPFCHEN GLEICHER GROESSE]
W. Trommsdorff, H. Wiegand, and J. Thelen Oct. 1966 18 p refs In GERMAN; ENGLISH Summary
(DLR-Mitt.-66-18; DVL-591) CFSTI: HC $3.00/MF $0.65

This report gives a short survey on physical laws of the generation and stability of a sequence of moving uniform-sized liquid droplets. Based on known publications, theoretical foundations are shown. They are followed by experimental results with water streams injected in calm air. Author

N67-19163# Aerodynamische Versuchsanstalt, Gottingen (West Germany).
ON THE VELOCITY DISTRIBUTION OF TURBULENT FLOW IN THE VICINITY OF POROUS WALLS [UEBER DIE GESCHWINDIGKEITSVERTEILUNG BEI TURBULENTER STROEMUNG IN DER NAEHE POROESER WAENDE]
J. C. Rotta Jun. 1966 31 p refs In GERMAN; ENGLISH summary
(AVA-FB-66-08; DLR-FB-66-45) CFSTI: HC $3.00/MF $0.65

The velocity distribution of turbulent flow in the vicinity of a wall with homogeneous blowing and sucking is treated theoretically. Calculated results are compared with experimental data. The sublayer flow is discussed in detail. Author

N67-19168# Lockheed Missiles and Space Co., Palo Alto, Calif.
DIMINUTION IN THE FRICTION IN THE TURBULENT FLOW OF A POLYVINYL ALCOHOL SOLUTION
V. S. Zav'ialova and G. F. Kobets [1966] 2 p refs Transl. into ENGLISH from Prikl. Mekh. i Tekhn. Fiz. (USSR), no. 5, 1966 p 133–134

The turbulent frictions in aqueous polyvinyl alcohol and glycerine solutions between two coaxial cylinders were measured. The apparatus used is diagrammed. Values of the viscosity and concentrations of the prepared solutions are listed. Data plots indicate that the effect of the diminution in turbulent friction of the solutions, as compared with water, depends on the viscosity of the solution being measured and the structure of the dissolved molecules. L.S.

N67-19170 Lockheed Missiles and Space Co., Palo Alto, Calif.
APPLICATION OF THE METHOD OF CHARACTERISTICS TO COMPUTE SUPERSONIC EXTERNAL GAS FLOWS IN THE PRESENCE OF NONEQUILIBRIUM PROCESSES
V. K. Dushin [1966] 6 p refs Transl. into ENGLISH from Russian

A two-dimensional method of characteristics for the analysis of the supersonic external flow domain taking account of nonequilibrium chemical conversion of the gas is elucidated. Underlying the method are the equations of characteristics and the characteristic relations presented for internal flows. A system of equations is examined which permits analysis of the multicomponent gas flows in both chemical nonequilibrium and in the completely equilibrium states in a single program. Results are presented of computations by means of the proposed scheme for the supersonic domain of a nonequilibrium dissociating as well as a completely equilibrium diatomic gas flow. The data required to begin the analysis of the supersonic domain are given on the first family characteristic and are obtained from an analysis of the region of influence of the bluntness by means of scheme II of the integral relations method. Author

N67-19172# Deutsche Versuchsanstalt für Luft- und Raumfahrt, Porz (West Germany). Institut fuer Angewandte Gasdynamik.
CONTRIBUTION TO THE DESCRIPTION OF REAL GAS INFLUENCES IN GASDYNAMICAL PROBLEMS [BEITRAG ZUR BESCHREIBUNG DER REALGASEINFLUSSE BEI GASDYNAMISCHEN PROBLEMEN]

Ernst Heinrich Hirschel Nov. 1966 58 p refs In GERMAN; ENGLISH summary
(DVL-564; DLR-Mitt.-66-20) CFSTI: HC $3.00/MF $0.65

In order to obtain a method for numerical determination of the behavior of air (considered as a real gas) in the range of low temperatures (50° up to 1500°K) and pressures (0.01 up to 100 atm), values of the virial coefficients and the specific heat were taken from tables of thermal properties and analytically represented by approximations. The equations for calculating the thermodynamic state of the real gas, the onedimensional flow and the shock wave relations were formulated on the basis of a paper by J. C. Crown. The equations for a perfect gas and a thermally perfect gas are contained in the equations for the real gas. Furthermore the conditions are investigated under which the assumptions perfect gas and thermally perfect gas as well as some numerical simplifications may be applied without excessive error. Numerical tables have not been included; instead, the calculated coefficients of the approximations have been listed. Author

N67-19174 Lockheed Missiles and Space Co., Palo Alto, Calif.
INVESTIGATION OF THE SINGULARITIES OF HYPERSONIC NONEQUILIBRIUM GAS FLOW AROUND BLUNT BODIES
G. N. Saiapin [1966] 3 p refs Transl. into ENGLISH from Mekh. Zhidkosti i Gaza (USSR), no. 6, 1966 p 115–116

A diatomic relaxing gas model which adequately reflects all the fundamental peculiarities in the behavior of a nonequilibrium gas with the vibrational degrees of freedom excited in the subsonic flow domain is hypothesized, and the system of equations describing such a flow is presented. Expressions for the boundary conditions on the shock are also given. The problem was solved numerically in a spherical coordinate system by a method proposed by G. F. Telenin. A diagram of the three-ray scheme used is depicted. Some peculiarities of the internal structure of the layer, established as a result of the computations, are shown graphically. Curves showing the distributions of the temperatures T and T_k along two rays, for three values of the nondimensional relaxation time; and the distribution of pressure in the shock layer on two rays for three values of the nondimensional time, are given. L.S.

N67-19273* General Applied Science Labs., Inc., Westbury, N. Y.
AN EXPERIMENTAL INVESTIGATION OF SUPERSONIC TURBULENT SLOT INJECTION
J. Dunn, A. Agnone, H. Feeley, and D. Soll Jun. 1964 55 p refs
(Contract NAS8-2686)
(NASA-CR-82461; GASL-TR-420) CFSTI: $3.00 CSCL 01A

An experimental investigation of supersonic turbulent mixing of a non-reacting light gas with air was carried out by ejecting hydrogen or helium from a wall slot into a Mach 2 air flow. Eight series of tests were made in which the jet mass flow parameter was varied from 0.11 to 1.37. Concentration and Mach number profiles were measured in the mixing region at positions from 15 to 78 slot heights downstream of the slot exhaust. Heat transfer rates were measured on the wall which was cooled by the light gas, and heat flux reductions of two hundred percent compared to no injection were observed at locations as far downstream as 78 slot heights. Author

N67-19281# Advisory Group for Aerospace Research and Development, Paris (France).
SEPARATED FLOWS, PART I
London, Tech. Editing and Reprod., Ltd., May 1966 490 p refs Proc. of the Specialists' Meeting Held in Rhode-Saint-Genese, Belgium, 10–13 May 1966
(AGARD-CP-4, Pt. I) CFSTI: HC $3.00/MF $0.65

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12. THE PREDICTION OF SEPARATION AND REATTACHMENT FLOW CHARACTERISTICS FOR TWO-DIMENSIONAL SUPERSONIC AND HYPERSONIC TURBULENT BOUNDARY LAYERS M. E. Childs, G. C. Paynter (Wash. Univ.), and E. Redeker (Boeing Co.) p 325–352 refs (See N67-19293 08-12)

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N67-19282# Centre National de la Recherche Scientifique, Meudon (France). Laboratoire d'Aerothermique.
THE BASE FLOW PROBLEM AT VERY LOW REYNOLDS NUMBERS [L'ECOULEMENT DE CULOT AUX FAIBLES NOMBRES DE REYNOLDS]
H. Viviand and S. A. Berger (Calif. Univ., Berkeley). *In* AGARD Separated Flows, Pt. I May 1966 p 1–29 refs In FRENCH (See N67-19281 08-12) cfsti: HC $3.00/MF $0.65

The base flow problem at very low Reynolds numbers is studied by means of the Stokes approximation. Stokes equations are solved, for two-dimensional and axisymmetric flows, in the half-space downstream of the base plane, for an arbitrarily given velocity field in this plane. Examples of two-dimensional base flows, calculated by means of this solution, are presented, and the influence of various parameters, used to define the flow conditions in the base plane, is studied. Author

N67-19283# Itek Corp., Palo Alto, Calif. Vidya Div.
THEORY OF LAMINAR SEPARATED FLOWS ON FLARED SURFACES INCLUDING SUPERSONIC FLOW WITH HEATING AND COOLING
J. N. Nielsen, L. L. Lynes, and F. K. Goodwin *In* AGARD Separated Flows, Pt. I May 1966 p 31–68 refs (See N67-19281 08-12) CFSTI: HC $3.00/MF $0.65

A method is developed based on the Dorodnitsyn method of integral relations to obtain solutions to the laminar boundary layer equations for separated flows induced on a plate by a ramp or induced on a cylinder by a conical flare. The analysis applies at any speed for a boundary layer under the influence of a specified pressure gradient for hot or cold walls. The analysis also applies to supersonic flow wherein the pressure distribution is not specified but is determined by free interaction between the boundary layer and the outer flow. The actual method of solution is by digital computer. A number of systematic calculations have been made to study the effects of Mach number, Reynolds number, and heating and cooling on laminar separation and reattachment. A number of comparisons made between theory and experiment for two-dimensional and axisymmetric flow as well as adiabatic and nonadiabatic flows show generally good agreement. A number of flow phenomena revealed by the calculations are presented. Author

N67-19284# California Univ., Berkeley.
SEPARATION OF LAMINAR BOUNDARY-LAYER FLOW PAST A CONCAVE CORNER
Maurice Holt *In* AGARD Separated Flows, Pt. I May 1966 p 69–87 refs (See N67-19281 08-12) CFSTI: HC $3.00/MF $0.65
(Grant AF-AFOSR-268-65)

Separation of a supersonic laminar boundary layer near a concave corner, due to a free interaction process, is investigated by the Method of Integral Relations. The shearing stress is represented as a two parameter function of the streamwise velocity component. Different representations are used in the attached and separated regions but, in both regions, they are applied all the way to the wall. As a result, the basic integral relation can always be integrated from the wall to the outer edge of the boundary layer and there is no need to split the separated layer into two parts. The solution of the attached flow equations runs smoothly into that of the separated layer equations. In a typical case the solution gives a continuously decreasing wall shearing stress and a pressure distribution outside the boundary layer increasing up to and beyond the separation point. Author

N67-19285# Imperial Coll. of Science and Technology, London (England). Dept. of Aeronautics.
HYPERSONIC STUDIES OF INCIPIENT SEPARATION AND SEPARATED FLOWS
D. A. Needham and J. L. Stollery *In* AGARD Separated Flows, Pt. I May 1966 p 89–119 refs (See N67-19281 08-12) CFSTI: HC $3.00/MF $0.65

Separation of both laminar and transitional boundary layers resulting from interaction with either an incident oblique shock or a wedge compression corner are investigated over the Mach number range 7.4 to 14.5 by means of schlieren photography and surface measurements of pressure and heat transfer rate. The concept of incipient separation is shown to be valid and an alternative method of detecting this condition is suggested based on heat transfer rate measurements. It is shown that all the available incipient separation data can be correlated in terms of the hypersonic small disturbance theory similarity parameter $M\alpha$ and the viscous interaction theory parameter $\bar{\chi}$. Author

N67-19286# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
BOUNDARY-LAYER SEPARATION AND REATTACHMENT WITH AND WITHOUT ABLATION
D. M. Kuehn and D. J. Monson *In* AGARD Separated Flows, Pt. I May 1966 p 121–145 refs (See N67-19281 08-12) CFSTI: HC $3.00/MF $0.65

Laminar boundary layer separation on ablating and nonablating axisymmetric bodies has been investigated at low Reynolds numbers and at a hypersonic Mach number. Two classes of models were studied: (1) cylinder-flare models and (2) blunt-faced base-flow models. Various flare and base angles were tested in order to span conditions for attached flow to separated flow. Three ablation materials were used. The flows were studied with the aid of pressure distributions, surface oil accumulations and streaks, burn patterns, and photographs of the glow about the models. The results show that large turning angles are possible for thick, laminar boundary layers at low Reynolds numbers. Ablation had, at most, only a small influence on the extent of laminar separation, but in some cases had considerable influence on surface pressures. Evidence is presented of ablation-induced transition of the boundary layer near separation on one of the models. Author

N67-19287# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
THEORETICAL AND EXPERIMENTAL STUDIES OF SEPARATED FLOWS INDUCED BY SHOCK-WAVE–BOUNDARY-LAYER INTERACTION
M. S. Holden *In* AGARD Separated Flows, Pt. I May 1966 p 147–180 refs (See N67-19281 08-12) CFSTI: HC $3.00/MF $0.65

The theoretical analysis describes the attached and separated interaction regions induced by the impingement of an oblique shock on the boundary layer, and by a forward-facing wedge on a flat plate. This theory compares favorably with pressure and heat transfer measurements in these interaction regions, both in adiabatic and highly cooled flows. The analysis also successfully describes the size and properties of an interaction region as the strength of the interaction is varied, and also predicts the interaction strength causing incipient separation. The experimental investigation was an exploratory study in a shock tunnel of the shock-wave–boundary-layer interaction developed over a flat plate-wedge model. The emphasis here was on the time to establish a steady separated flow, the effect of finite model span on the attached and separated flows, and the determination and correlation of incipient separation conditions. Author

N67-19288# General Dynamics/Convair, San Diego, Calif. Space Science Lab.
NUMERICAL CALCULATION OF SEPARATED FLOW FIELDS
Hans U. Thommen and Richard J. Magnus *In* AGARD Separated Flows, Pt. I May 1966 p 181–205 refs (See N67-19281 08-12) CFSTI: HC $3.00/MF $0.65

A numerical method for the integration of the Navier–Stokes equations for unsteady, compressible flow is discussed. The

difference scheme proposed is a two-step Lax–Wendroff scheme, modified to take into account the influences of viscosity and heat conduction. The accuracy and stability of the difference scheme are studied theoretically and numerically, using either the full Navier–Stokes equations or the simpler Burger equation. The application to separated flow fields is discussed and some observations on early pilot calculations are presented. Author

N67-19289# California Univ., Los Angeles. Dept. of Engineering.
STUDIES ON LAMINAR AND TURBULENT FREE SHEAR LAYERS WITH A FINITE INITIAL BOUNDARY LAYER AT SEPARATION
A. F. Charwat and J. Der, Jr. (Northrop Corp., Hawthorne, Calif.) *In* AGARD Separated Flows, Pt. I May 1966 p 207–240 refs (See N67-19281 08-12) CFSTI: HC $3.00/MF $0.65
(Grant NSF GP-2350)

Initial results of a coupled experimental and analytical (numerical) study of the development of a free shear layer originating from an attached boundary layer of finite thickness are described. An unusual transformation of the boundary layer equations which is particularly well suited for numerical integration of free shear layer problems is presented. Calculations for both symmetrical (incompressible) wakes behind an infinitely thin plate and for unsymmetrical (compressible) free shear layers in laminar flow for families of initial profiles are shown; the sensitivity to pressure gradients imposed on the shear layer is demonstrated. Partial experimental data showing the development of turbulent shear layers immediately downstream of separation are included. Author

N67-19290# France. Office National d'Etudes et de Recherches Aeronautiques, Chatillon-sous-Bagneux.
CONTRIBUTION TO THE EXPERIMENTAL STUDY OF LAYER OF ISOBARIC TURBULENT MIXTURE OF A SUPERSONIC FLOW [CONTRIBUTION A L'ETUDE EXPERIMENTALE DE LA COUCHE DE MELANGE TURBULENT ISOBARE D'UN ECOULEMENT SUPERSONIQUE]
M. Sirieix and J. L. Solignac *In* AGARD Separated Flows, Pt. I May 1966 p 241–270 refs In FRENCH (See N67-19281 08-12) CFSTI: HC $3.00/MF $0.65

A review is made of the theoretical results available, and an experimental study, carried out at Mach 3 and 4, is presented. The evolution of the velocity, temperature and concentration curves is analyzed, particularly in the area of the isobaric turbulent mixture dependent on the pre-existing boundary layer. Author

N67-19291# Belgian Air Force, Brussels.
SUPERSONIC TURBULENT MIXTURE AND APPLICATION TO THE PROBLEMS OF REATTACHMENT [MELANGE SUPERSONIQUE TURBULENT ET APPLICATION AUX PROBLEMES DE RECOLLEMENT]
R. Jacques and A. Gailly *In* AGARD Separated Flows, Pt. I May 1966 p 271–301 refs In FRENCH (See N67-19281 08-12) CFSTI: HC $3.00/MF $0.65

A method of determining velocities, mass flows, temperatures and viscous stresses within a turbulent, compressible isobar mixing layer is established. It is applicable in the region where the velocity profiled may be considered as similar and when the flow is steady, isoenergetic and two-dimensional. The method may be extended to the case of an axisymmetric flow and remains valid for laminar flow. The results obtained through this method are used for the calculation of the base pressure or the reattachment angle, with or without injection, by applying the Korst–Chapman criterion. In view of the disagreement between theoretical and experimental results, a correlation method based on the experimental results of Carrière is proposed; it is valid for bi-dimensional reattachment as well as conical reattachment. Author

N67-19292# Avco Corp., Wilmington, Mass. Aerophysics Dept.
TURBULENT MIXING IN SUPERSONIC FLOW PAST SLENDER BODIES WITH LARGE BLOWING
Barry L. Reeves *In* AGARD Separated Flows, Pt. I May 1966 p 303–324 refs Sponsored by AF Ballistic Systems Div. (See N67-19281 08-12) CFSTI: HC $3.00/MF $0.65

Supersonic flow past slender bodies with large blowing from the surface is investigated. If the flow in the blowing region is turbulent, in some circumstances the mean flow can be self-preserving, and the equations of mean motion for constant-density flow behind the bow shock wave are satisfied by conical forms of the turbulent and mean velocities. By introducing a scalar coefficient of eddy viscosity, solutions of the similarity equations are obtained in terms of a turbulent Reynolds number. It is shown that, for normal injection, and for sufficiently large values of the Reynolds number, the blowing region consists of three subregions; a virtually inviscid region near the surface, a shear layer along the dividing streamline, and an intermediate turning layer in which $V/U \approx O(1)$. Quantitative results for the effect of large blowing on the flow fields about a flat plate and a slender cone are obtained. Author

N67-19293# Washington Univ., Seattle
THE PREDICTION OF SEPARATION AND REATTACHMENT FLOW CHARACTERISTICS FOR TWO-DIMENSIONAL SUPERSONIC AND HYPERSONIC TURBULENT BOUNDARY LAYERS
Morris E. Childs, Gerald C. Paynter, and Eleanor Redeker (Boeing Co., Seattle, Wash.). *In* AGARD Separated Flows, Pt. I May 1966 p 325–352 refs Sponsored by AFSC (See N67-19281 08-12) CFSTI: HC $3.00/MF $0.65

The method is based on a control volume analysis of the separation bubble. Only initial boundary-layer properties and shock strength or ramp angle must be known. The concept of an equivalent constant pressure free shear layer which allows for the effect of an initial boundary layer is used in treating the mixing process adjacent to the separation bubble. The actual shear layer is replaced by an equivalent mixing layer. This hypothetical mixing layer is assumed to be the result of the mixing between a uniform stream and an ambient fluid at rest. The origin of the equivalent layer and the relationship between the equivalent and actual flows is established by equating, at separation, the momentum and mass fluxes below an external reference stream surface in the equivalent layer to the momentum and mass fluxes below the corresponding stream surface in the actual flow. The use of the equivalent layer allows the shear stress along the dividing stream surface to be estimated, and provides information on the velocity distribution in the mixing layer. Author

N67-19294# France. Office National d'Etudes et de Recherches Aeronautiques, Chatillon-sous-Bagneux.
FUNDAMENTAL EXPERIENCES OF THE TURBULENT REATTACHMENT OF A SUPERSONIC JET [EXPERIENCES FONDAMENTALES SUR LE RECOLLEMENT TURBULENT D'UN JET SUPERSONIQUE]
M. Sirieix, J. Miranda, and J. Delery *In* AGARD Separated Flows, Pt. I May 1966 p 353–391 refs In FRENCH (See N67-19281 08-12) CFSTI: HC $3.00/MF $0.65

A survey is made of the basic data yielded by previous experiments on turbulent reattachment, and a detailed analysis of the recompression field from data provided by refined methods is presented. Various characteristics are brought out; mainly, the existence of critical points and of a law of similarity in the evolution of wall pressures. An attempt has been made to acquire a more precise knowledge of the reattachment structure; interferometry methods have made it possible to obtain the evolution of the boundary layer thickness δ, δ^*, δ^{**} during reattachment. Author

N67-19296# Royal Aircraft Establishment, Bedford (England).
TWO-DIMENSIONAL TURBULENT REATTACHMENT AS A BOUNDARY-LAYER PROBLEM
J. E. Green *In* AGARD Separated Flows, Pt. I May 1966 p 393–427 refs (See N67-19281 08-12) CFSTI: HC $3.00/MF $0.65

A conventional boundary layer analysis is extended to treat the development of a steady turbulent wake downstream of a base. By a process of iterative calculation, a solution is obtained in which the outer potential flow and the wake flow are compatible and mutually dependent. The wake calculation takes into account the reversed flow in the dead air region, and the solution includes a description of the reattachment process. Attention is confined to steady, two-dimensional, incompressible base-flows. A typical solution for this type of flow is described in detail, and is shown to be in good qualitative agreement with measurements of reattachment behind rearward-facing steps. A way of qualitatively discussing reattachment is suggested, and a recent correlation of experimental data is supported. Author

N67-19297# Advisory Group for Aerospace Research and Development, Paris (France).
SEPARATED FLOWS, PART II
London, Tech. Editing and Reprod., Ltd., May 1966 405 p refs Proc. of the Specialists' Meeting held in Rhode-Saint-Genese, Belgium, 10–13 May 1966
(AGARD-CP-4, Pt. II) CFSTI: HC $3.00/MF $0.65

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N67-19298# National Physical Lab., Teddington (England).
INVESTIGATION INTO THE EFFECT OF BASE BLEED ON THE FLOW BEHIND A TWO-DIMENSIONAL MODEL WITH A BLUNT TRAILING EDGE
P. W. Bearman *In* AGARD Separated Flows, Pt. II May 1966 p 479–508 refs (See N67-19297 08-12) CFSTI: HC $3.00/MF $0.65

The effects of base bleed on the flow about a two-dimensional model with a blunt trailing edge were examined at Reynolds numbers, based on model base height, between 1.3×10^4 and 4.1×10^4. The ratio of total boundary-layer thickness at the trailing edge to model base height was approximately 0.4. Measurements were made of base pressure, vortex shedding frequency and the distance to vortex formation. With a sufficiently large bleed quantity the regular vortex street pattern disappeared and the base drag of the section could be reduced to about a third of its original value. The base pressure was found to vary linearly with the inverse of the vortex formation distance. Results of a previous splitter plate investigation were found to agree closely with those of the present experiments. Author

N67-19301# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Berlin (West Germany). Inst. fuer Turbulenzforschung.
THE INSTABILITY AND THE FORMATION OF VORTICES IN A FREE BOUNDARY LAYER
A. Michalke and P. Freymuth *In* AGARD Separated Flows, Pt. II May 1966 p 575–595 refs (See N67-19297 08-12) CFSTI: HC $3.00/MF $0.65

The instability and the formation of vortices in free boundary layers are investigated for large Reynolds numbers, experimentally by means of the hot-wire technique and theoretically by means of the inviscid linearized stability theory of spatially growing disturbances. It is found that, by the influence of sound, sinusoidal disturbances with a certain initial disturbance of magnitude proportional to the sound pressure are excited which grow exponentially with downstream distance. The growth rate is nearly independent of the Reynolds number, but depends on the Strouhal number. Also the formation of vortices does not seem to be noticeably effected by viscosity. From the theoretical results it can be concluded that the linearized stability theory of spatially growing disturbances gives a good description of the instability properties observed in the experiments. Furthermore, from the calculated streakline pattern it follows that the linearized theory includes approximately the rolling-up process of the free boundary layer. Author

N67-19302# Deutsche Versuchsanstalt für Luft- und Raumfahrt, Porz (West Germany). Inst. fuer Angewandte Gasdynamik.

THREE-DIMENSIONAL EFFECTS IN SHOCK-SEPARATED FLOW REGIONS AHEAD OF LATERAL CONTROL-JETS ISSUING FROM SLOT NOZZLES OF FINITE LENGTH

F. Maurer *In* AGARD Separated Flows, Pt. II May 1966 p 597–634 refs (See N67-19297 08-12) CFSTI: HC $3.00/MF $0.65

The separated flow field ahead of side-jets expanding from slot nozzles of finite length into supersonic free jet wind-tunnel flows is investigated by means of pressure distribution measurements, surface oil-flow pictures and schlieren pictures. The oil-flow pictures show the lines of flow separation as well as streamlines of the two flows. The streamlines inside the separated regions show a remarkable influence from the lateral edges of the jets. The existence of a crossflow, superimposed on the two-dimensional flow inside the separated region ahead of the jet, is verified. Some interesting three-dimensional perturbations in the process of jet attachment downstream of the jet exit are described. The experimental evidence provides a basis for an analytical approach to the problem. The results of iterative flow-field calculations agree rather well with the experiments. The discussion of assumptions introduced in the analysis contributes to a better understanding of the mechanism of three-dimensional flow interaction. Author

N67-19304# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A THEORETICAL AND EXPERIMENTAL INVESTIGATION OF SECONDARY JETS IN A MACH 6 FREE STREAM WITH EMPHASIS ON THE STRUCTURE OF THE JET AND SEPARATION AHEAD OF THE JET

James R. Sterrett and John B. Barber *In* AGARD Separated Flows, Pt. II May 1966 p 667–700 refs (See N67-19297 08-12) CFSTI: HC $3.00/MF $0.65

An experimental and theoretical investigation to determine the actual fluid processes in the interaction of secondary gaseous jets with a primary flow has been conducted. The experimental phase of the program consisted of an investigation of free jets exhausting against a flat plate, including interferograms taken with a laser grating interferometer, and an investigation conducted in a Mach 6 wind tunnel with secondary jets of various exit Mach numbers issuing perpendicularly from a flat plate. The theoretical investigation included the calculation of various free jet patterns by the use of the two-dimensional characteristic theory for various boundary conditions and the examination of various shock calculations for different shock patterns. Since this is a problem area where separation plays a prominent role, an analogy between different types of separated flow is presented. From these studies, realistic flow models have been constructed and various design parameters have been determined experimentally. Author

N67-19306# Illinois Univ., Urbana.

DYNAMICS AND THERMODYNAMICS OF SEPARATED FLOWS

Helmut H. Korst *In* AGARD Separated Flows, Pt. II May 1966 p 701–746 refs (See N67-19297 08-12) CFSTI: HC $3.00/MF $0.65

(Grant NsG-13-59)

Finite velocities within wakes account for convective mechanisms controlling energy transfer to and across separated flow regions. The wake flow field is maintained by the balance of mechanical energy transferred from the free stream and that dissipated within the wake. A systems analysis concerned with mechanical energy forms the basis for the dissipative flow model, while a thermodynamic systems analysis delineates individual components of energy transfer for use in a heat transfer model for wake flows. Quantitative exploitation is restricted to such problems in the turbulent flow regime with $Pr_t=1$ for which individual dissipative mechanisms, and convective processes, can be rationally analyzed. For certain classes of steady wake flows where sufficiently simple and non-interacting individual flow components can be identified, the dissipative flow model determines a physically meaningful characteristic wake velocity. This characteristic wake velocity forms the basis for quantitative analyses determining drag coefficients and overall and local heat transfer coefficients. Theoretical results reflect the proper trends attributed to cavity geometry, Reynolds number, effect of approaching boundary layers, and mass bleed into the cavity, as is borne out by comparison with experimental evidence. Author

N67-19310# Aerodynamische Versuchsanstalt, Gottingen (West Germany).

THE WAKE PRESSURE BEHIND WEDGES AS INFLUENCED BY SPLITTER PLATES AND SUCTION

M. Tanner *In* AGARD Separated Flows, Pt. II May 1966 p 887–909 refs (See N67-19297 08-12) CFSTI: HC $3.00/MF $0.65

Two different types of measurements were carried out: The first deal with the influence of splitter plates of different length. The second concern the influence of suction of air through a long porous splitter plate. A pronounced effect of both the length of the splitter plate and the suction on the flow pattern has been found. Based on the experiences gained in the experiments previously mentioned, a theory of the flow in wakes has been established. The analysis shows that the amount of the incoming flow and of the outgoing flow of the closed wake bubble are the significant parameters. It is indicated also that the actually existing base pressure depends on the amount of outflow from the wake bubble. It has been possible to derive an equation relating the base pressure and drag coefficient to the amount of outflow of the wake. A comparison of the theoretical outflow with experiments shows good agreement in the whole region of wedge angles from 0° to 180° Author

N67-19311# Boeing Co., Seattle, Wash. Missile and Information Systems Div.

THEORETICAL ANALYSIS OF LAUNCH VEHICLE BASE FLOW

R. J. Dixon and R. H. Page (Rutgers Univ., New Brunswick, N. J.) *In* AGARD Separated Flows, Pt. II May 1966 p 911–940 refs (See N67-19297 08-12) CFSTI: HC $3.00/MF $0.65

An analytical model of the flow field at the base of a vehicle with propulsion nozzles has been developed. The model has been used to calculate the heat transfer at the base stagnation point. The pressure distribution and other flow field parameters are also determined for the base region. The theoretical analysis and a typical comparison with experimental data are presented. Author

N67-19312# National Lucht-en Ruimtevaartlaboratorium, Amsterdam (Netherlands).

WIND TUNNEL EXPERIMENTS ON UNSTEADY CAVITY FLOW AT HIGH SUBSONIC SPEEDS

B. M. Spee *In* AGARD Separated Flows, Pt. II May 1966 p 941–974 refs (See N67-19297 08-12) CFSTI: HC $3.00/MF $0.65

Wind tunnel experiments have been done on the unsteady flow over a cavity system at high subsonic speeds. The investigation is part of an experimental programme on the interaction between sound waves and two-dimensional transonic flows. The tests were performed on a two-dimensional cavity system consisting of a rectangular gap connected with a resonance chamber. The Mach number range was from 0.4 to 0.85. The investigation involved

schlieren and shadowgraph observations, as well as measurements of the frequency and intensity of the radiated field. Periodically fluctuating flows can be characterised by their feedback mechanism. In the present tests the pressure related to the resonance chamber oscillations is the feedback force. This results in a relatively simple and clean cavity flow. The cavity behaves, at some distance, like an acoustic monopole and emits intense acoustic radiation. The radiated sound field in general meets requirements concerning two-dimensionality and variability of frequency and intensity. Author

N67-19328*# Purdue Univ., Lafayette, Ind. Jet Propulsion Center.
MASS TRANSFER IN ANNULAR, TWO-PHASE FLOW Final Report
G. R. Schneiter Feb. 1966 183 p refs
(Grants NsG-592; NSF G-21976)
(NASA-CR-82543; JPC-419; F-66-2) CFSTI: HC $3.00/MF $0.65 CSCL 20D

Mass transfer rate and surface characteristics of the air-water interface during the annular two-phase flow of air and water in a vertical pipe were measured as a function of (1) water Reynolds number from 23 to 1350, (2) air inlet temperature from 110° to 350°F, and (3) test section length of 8 to 40 in. Mass transfer rate was determined by the increase in the specific humidity of the air stream as it passed through the test section; and liquid film thickness, wave velocity, and surface area were measured by a light absorption technique. The water Reynolds number had no effect on the dimensionless mass transfer coefficient, and there was a negligible increase in the air-water interface due to waves on the liquid film surface. Appendixes give details of the experimental apparatus and the procedure, mass transfer data calculations, and method of measuring surface characteristics. M.W.R.

N67-19355*# Brown Engineering Co., Inc., Huntsville, Ala. Propulsion Dept.
NUMERICAL SOLUTION OF THE FLOW FIELD IN THE THROAT REGION OF A NOZZLE
Lee M. Saunders 19 Aug. 1966 22 p refs
(Contract NAS8-20073)
(NASA-CR-82601; BSVD-P-66-TN-001) CFSTI: HC $3.00/MF $0.65 CSCL 01A

A time dependent finite difference technique was used to compute the flow field in a nozzle throat region. Steady state results are obtained as an asymptotic solution in time. This report describes the finite difference solution and presents comparisons with both experimental data and theoretical work. R.L.

13 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences.

N67-18212# Illinois State Water Survey, Urbana. Atmospheric Sciences Section.
ATMOSPHERIC ELECTRICAL SOUNDINGS AND THEIR RELATION TO PRECIPITATION Final Report
Wayne E. Bradley and Glenn E. Stout 15 Nov. 1966 27 p refs
(Grant NSF GP-3479)

Forty-five aircraft soundings were flown over West Plains, Missouri, during the summer to determine the electrical nature of the atmosphere up to 10,000 feet msl. The results from the soundings obtained are described and compared with the occurrence or nonoccurrence of precipitation in the 5 hours following each sounding. Usually the potential gradient was found to increase in the first 1000 to 3000 feet above the surface and then decrease to the top of the sounding. Early afternoon soundings which were followed by precipitation showed an unusually high potential gradient above 7000 feet, but a similar situation occurred in the presence of vertical mixing to 10,000 feet in the absence of precipitation. It is concluded that precipitation is not preceded by a unique set of atmospheric electrical conditions in the lower atmosphere. Author

N67-18213# Bureau of Mines, College Park, Md.
COMPARISON OF TWO METHODS FOR STUDYING RELATIVE PERFORMANCE OF EXPLOSIVES IN ROCK
Thomas E. Stykhouse, Lyle W. Colburn (Dow Chem. Co., Midland, Mich.), Thomas R. Bur, and Harry R. Nichols 1967 48 p refs
(BM-RI-6888)

The strain and pressure gauge methods for evaluating the relative performance of explosives in rock were compared. This comparison was based on a study of the responses of strain and pressure gauges to explosion-generated seismic waves. Several explosives, representing a wide range of detonation pressures, were used. In general the relative performance of these explosives, as determined from amplitude, impulse parameter, and energy parameter measurements, is the same if the compressive portion of the strain pulse and the comparable portion of the pressure pulse are considered. Other similarities and differences of the two methods are also discussed. Author

N67-18244*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
WHOLE-ROCK RUBIDIUM-STRONTIUM AGE OF THE SILURIAN-DEVONIAN BOUNDARY IN NORTHEASTERN NORTH AMERICA
Michael L. Bottino and Paul D. Fullagar [1965] 25 p refs Submitted for Publication
(NASA-TM-X-57221) CFSTI: HC $3.00/MF $0.65 CSCL 08G

Nine whole rock samples of the Skala (post-Ludlow, pre-Gedinnian) age volcanics from the Eastport Formation, Eastport, Maine, and nine whole rock samples of Lower Devonian (New Scotland age) volcanics from the Hedgehog Formation, Presque Isle, Maine, have been analyzed for their rubidium, strontium and strontium isotopic composition. The analyses of the Eastport volcanics produced an isochron age of 412±5 M.Y. ($\lambda_{Rb}87 = 1.39 \times 10^{-11}$ year^{-1}) with an initial ratio of 0.707±0.001. The Hedgehog Formation volcanics yielded an isochron age of 413±10 M.Y. with an initial ratio of 0.706±0.002. Combining the results gives an age of 413±5 M.Y. for the Silurian-Devonian boundary; this age is based on the average of the age values of the individual samples, and the precision assigned is two standard deviations of the mean of the individual ages. This age is a precise measurement of the Silurian-Devonian boundary in northeastern North America and is in reasonable agreement with recent time scale estimates considering the uncertainty of the Rb^{87} decay constant. Author

N67-18337*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
CONVECTION AND MAGNETOSPHERIC TURBULENCE
G. Atkinson *In its* Space Programs Sum. No. 37-42, Vol. IV 31 Dec. 1966 p 163-165 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

In the analysis performed, consideration is given to the onset of turbulence driven by the convecting shear flow. The turbulence is of the convective type, involving the small scale interchange of flux tubes and, as such, is essentially two dimensional. A two-dimensional model is adopted with magnetic field lines in the z direction with their feet in plane ionospheres at z=0, and z=L. Motion is therefore confined to the x and y directions. Although in an actual flow, the field lines would adopt a parabola-like shape, consideration of the currents indicates that the field lines stay within a few degrees of the z-axis up to foot velocities $\approx 10^4$ m/sec. The solution indicates that turbulent convective motions cannot be driven by shear flows and cannot convect within the magnetosphere. They must, in fact, be the result of a local energy source other than shear flow, such as differences in the properties of the plasma in the flux tubes, or any externally applied electric field. M.G.J.

N67-18352*# National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York.
EARTH'S MAGNETIC FIELD
Harold L. Stolov [1965] 25 p refs Submitted for publication
(NASA-TM-X-57326) CFSTI: HC$3.00/MF$0.65 CSCL 08N

Basic data are presented to explain the everchanging phenomenon of the earth's magnetic field. Consideration is given to measurement techniques and results, the dipole field, spherical harmonic analysis, the potential of the main field above the earth, the magnetosphere, quiet day geomagnetic variations, dynamo theory on the origin of the ionospheric current systems, and some relationships of the geomagnetic field. A tabulation of the geographic latitude and longitude of various magnetic poles is included. M.G.J.

N67-18375# Kiel Univ. (West Germany). Inst. of Pure and Applied Nuclear Physics
MEASUREMENT OF GAMMA RADIATION SPECTRUM BETWEEN 0.2 AND 12 GeV AT AN ATMOSPHERIC DENSITY OF 26 g/cm^2 [MESSUNG DES ULTRASTRAHLUNGS-GAMMASPEKTRUMS VON 0.2 BIS 12 GeV IN EINER ATMOSPHAERISCHEN TIEFE VON 26 g/cm^2]
Diederich Koehn and Klaus Roehrs Nov. 1966 8 p refs In GERMAN; ENGLISH summary
CFSTI: HC$3.00/MF$0.65

The integral and differential energy spectra of the secondary cosmic ray photons between 0.2 and 12 GeV are measured at an atmospheric density of 26 g/cm^2 using a balloon-borne lead-scintillator-sandwich-spectrometer. The shape of the integral spectrum can be approximated by a power law $I_\gamma(>E)\gamma E^{-0.85\pm0.05}$ in the energy range between 0.2 and 8 GeV. The production-rate of photons in the upper atmosphere is derivated. A comparison is made with the results of other authors. Author (ESRO)

N67-18427# Institut d'Aeronomie Spatiale de Belgique, Brussels.
THE TEMPERATURE COUPLING OF IONS IN THE IONOSPHERE
Peter M. Banks 1966 35 p refs Submitted for Publication
/ts Aeronomica Acta No. 50 A
(A-50-1966) CFSTI: HC$3.00/MF$0.65

An investigation has been made of the extent to which O^+, He^+, and H^+ ions can be considered as having a common temperature in the ionosphere. By assuming that each ion gas has its own Maxwellian velocity distribution, energy balance equations including the effects of heating by the electron gas, cooling by the neutral atmosphere, and energy coupling between the ion species have been obtained. Solutions to the energy equations for three models of the neutral atmosphere indicate that the H^+ and He^+ ion temperatures are higher than the O^+ temperature in the regions between 250 and 650 km. A peak temperature difference greater than two hundred degrees occurs for H^+ and O^+ ions, while values reaching one hundred degrees are noted for the He^+–O^+ seperation. An explanation of the temperature inequality has been made in terms of atmospheric and ionospheric conditions, showing that the altitude extent of ion temperature separation increases for rising thermospheric and electron temperatures and decreases for larger electron densities. Author (ESRO)

N67-18432* National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York.
THE UPPER ATMOSPHERE IN THE RANGE FROM 120 TO 800 km
I. Harris and W. Priester, comp. 25 Aug. 1964 233 p refs
(NASA-TM-X-57249) CFSTI: $3.00 CSCL 04A

Variations in atmospheric densities from 1958 to 1963, covering nearly a full phase of decreasing solar activity within the 11-year solar cycle, are outlined and papers which revealed and confirmed these variations are briefly reviewed. A new reference atmosphere is proposed which accounts for these variations and provides an easy comparison between measurements of atmospheric parameters taken at different heights and times, in particular the thermosphere and exosphere in the range from 120 to 800 km for every two hours in local time. The models attempt to reach an agreement between densities derived with the inflatable sphere method below 130 km, and the requirement to represent satellite drag data above 200 km. Basic relations, tables of the atmospheric properties in the range from 120 to 800 km for ten different levels of solar activity, the accuracy of the data, and a comparision with individual measurements of atmospheric parameters are presented. The latter includes a discussion of the 27-day variation, the geomagnetic activity effect, the semi-annual variation, and the data reduction procedure. R.N.A.

N67-18442* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
COMMENTS ON "A STUDY OF HYDROGEN DIFFUSION IN THE EARTH'S UPPER ATMOSPHERE NEAR THE CRITICAL LEVEL"
M. Liwshitz [1965] 6 p refs Submitted for publication
(NASA-TM-X-57177) CFSTI: HC$3.00 CSCL 04A

Two different approaches to the problem of hydrogen diffusion near the critical level by applying the Monte Carlo method to a simplified physical model of the transport process are considered. Discrepancies in the results of these two methods are examined. One reason for different conclusions is the different extent and boundaries of the region chosen for investigation. In one method a rather broad region was adopted for the experiment, amounting to a kinetic depth of 5–6 mean free paths (m.f.p.). In the other method the region of investigation was of a much smaller extent totalling slightly over 1 m.f.p. in the vertical direction. Another source of diverging results was in the different evaluation of the m.f.p. used in computing the location of the next collision. In one case the m.f.p. was dependent on the speed with which the hydrogen atom followed emerged from its last collision, and the temperature of the medium. In the other case the m.f.p. was determined by the dynamic parameters of both the particular hydrogen atom and the future collision partner. A further source of significant discrepancy concerned the methods of audit applied. S.P.

N67-18668 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
EXPERIMENTAL ANALYSIS OF INFRARED CONTRAST BETWEEN THE EARTH AND SPACE [ANALYSE EXPERIMENTALE DU CONTRASTE INFRAROUGE ENTRE LA TERRE ET L'ESPACE]

A. Girard *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 11 refs (See N67-18661 08-34) CFSTI: $3.00

Recounted briefly is a nighttime experiment on the emissive zone of transition between the earth and space, which results from the existence of atmospheric gas due to radiative properties in the infrared region, in the spectral domain from 1 to 35 microns. Measurements were made between 80 and 182 km altitude, and confirm the fact that the infrared horizon does not coincide with the geometric horizon. Results obtained are considered to be in good agreement with previous theoretical work although a weak amplitude signal was observed at 80 km, an altitude at which radiation would become negligible according to calculations made with atmosphere models. Transl. by R.I.I.

N67-18709*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

HIGH LATITUDE MAGNETIC DISTURBANCES (A BRIEF REVIEW WITH INITIAL RESULTS FROM MOTION PICTURE PRESENTATION)

J. P. Heppner Aug. 1966 34 p refs Presented at the Advanced Study Inst. on Aurora and Airglow, Keele Univ., England, Aug. 1966 Submitted for Publication

(NASA-TM-X-55649; X-612-66-455) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Geomagnetic time and latitude distribution of magnetic disturbance at auroral and polar cap latitudes are discussed, and a historical review of disturbance pattern studies, beginning with those of Birkeland in the early 1900's, is presented. Analyses of magnetic storms have been made by (1) averaging of a number of disturbances or a number of days, (2) constructing disturbance patterns or equivalent current systems for specific hours by using hourly mean values, and (3) relating magnetic disturbance patterns to auroral behavior. Film display of disturbance patterns is considered; and it is noted that the digitizing of magnetograms of 2.5-min intervals has permitted the use of time variations in these patterns. This film display is considered in terms of circuit closure, biased distributions, return current, pattern repetition of the same UT on successive days, and pattern movements in geomagnetic time. The persistence of the positive bay disturbance is noted, as is the nearly identical behavior of the polar cap disturbances at Thule and Resolute Bay. M.W.R.

N67-18718 Physical Research Lab., Ahmedabad (India). Ionospheric and Radio Physics Section.

MONTHLY MEDIAN CHARACTERISTIC OF THE IONOSPHERE OVER THUMBA (8° 33'N, 76° 58'E)

R. G. Rastogi Jan. 1966 13 p

CFSTI: $3.00

Hourly ionospheric data tables with the monthly median characteristics of the ionosphere over India are presented. Data are obtained for the Thumba area. G.G.

N67-18736*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A SIMPLIFIED FORMULA FOR IONOSPHERIC FARADAY ROTATION AT FREQUENCIES ABOVE 100 Mc/s

T. J. Lynch Oct. 1966 16 p refs

(NASA-TM-X-55682; X-520-66-488) CFSTI: HC $3.00/MF $0.65 CSCL 04A

A simple formula for ionospheric Faraday rotation is derived starting from Maxwell's equations and using the following major assumptions: the ionosphere is a homogeneous gyrotropic medium with a scalar permeability and a tensor permittivity; the earth's magnetic field is constant and directed along the path of propagation; the ionosphere imposes no attenuation on the linearly polarized entering wave; and the carrier frequency is of the order of 100 Mc/s or higher. Author

N67-18784*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A DEVELOPMENT OF THE EARTH'S GRAVITATIONAL POTENTIAL FROM THE SIXTH THROUGH THE TWENTY-FIFTH ZONAL HARMONIC

Theodore L. Felsentreger and Eric L. Victor Nov. 1966 19 p

(NASA-TM-X-55695; X-547-66-550) CFSTI: HC $3.00/MF $0.65 CSCL 08N

That part of the earth's gravitational potential from the sixth zonal harmonic through the twenty-fifth, along with its partial derivatives with respect to an inertial geocentric coordinate system, is expressed in a form suitable for inclusion in the numerical integration of position partial derivatives for an earth satellite. Author

N67-18789*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

SIMULTANEOUS CLOUD ALBEDO MEASUREMENTS TAKEN WITH AIRBORNE SOL-A-METERS AND AIRBORNE AND NIMBUS II ORBITING MEDIUM RESOLUTION INFRARED RADIOMETER

B. A. Sparkman and G. T. Cherrix Feb. 1967 24 p refs

(NASA-TM-X-55705; X-622-67-49) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Albedos of cloud, desert, and ocean surfaces were measured simultaneously with airborne Sol-A-Meters, two short-wave channels of an airborne medium resolution infrared radiometer (MRIR), and a single short-wave channel of the Nimbus II MRIR. Good agreement was found in coordinated measurements from all of the instruments. Author

N67-18910* Consultants and Designers, Inc., Arlington, Va.

PULSATIONS OF AURORA GLOW AND IRREGULAR SPP OF THE GEOMAGNETIC FIELD [PUL'SATSII SVECHENIYA POLYARNYKH SIYANIY I IRREGULYARNYYE KPK GEOMAGNITNOGO POLYA]

18 Nov. 1965 8 p refs Transl. into ENGLISH from Geomagnetizm i Aeronomiya (Moscow), v. 5, no. 5, 1965 p 874–877

(Contract NAS5-3780)

(NASA-CR-82156; ST-AA-GM-10417) CFSTI: HC $3.00 CSCL 04A

A dynamo theory of irregular polar corona pulsations (SPP) of the geomagnetic field occurring during polar bay-like disturbances is discussed. A formula is proposed which links the SPP amplitudes with the pulsations of aurora glow. Author

N67-18948*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

ELECTRON DENSITIES AND SCALE HEIGHTS IN THE TOPSIDE IONOSPHERE: ALOUETTE I OBSERVATIONS RECORDED AT HAWAII, WINTER 1962–1963, SUMMER 1963

Lawrence Colin and Kwok-Long Chan Washington, NASA, 1967 286 p refs

(NASA-SP-3038) CFSTI: HC $3.00 CSCL 04A

Tabulations and graphs of electron density and plasma scale height data computed from Alouette I topside sounder ionograms are presented. The Alouette I satellite is in an almost circular orbit at an altitude of 1000 kilometers, with an inclination of 80.5° and an orbital period of 105.4 minutes. The universal time, local time, geographic latitude, geographic longitude, and magnetic dip angle for the first and last ionograms of each Alouette I pass are included. A.G.O.

N67-18958*# Volt Technical Corp., Washington, D. C.
ON THE DISTRIBUTION OF ALFVEN VELOCITY IN THE MAGNETOSPHERE [K VOPROSU O RASPREDELENII AL'FVENOVSKOY SKOROSTI V AMGNITOSFERE]
L. L. Van'yan and K. Yu. Zybin 30 Jan. 1967 4 p refs Transl. into ENGLISH from Kosmich. Issled. (Moscow), v. 4, no. 6, 1967 p 935–936
(Contract NAS5-12487)
(NASA-CR-82434; ST-PF-GM-10557) CFSTI: HC $3.00/MF $0.65 CSCL 04A

From a peculiarity in the distribution of Alfvén velocity in the magnetosphere the authors derive a series of consequences that are of importance for the understanding of the nature of geomagnetic micropulsations. The reasonings are based upon the data relative to the plasma jump, called "knee", of which a large number has been lately accumulated. Author

N67-18967*# National Aeronautics and Space Administration, Washington, D. C.
METHODS OF INVESTIGATING THE ATMOSPHERE WITH ROCKETS AND SATELLITES
A. A. Kmito Feb. 1967 350 p refs Transl. into ENGLISH of the book "Metody Issledovaniya Atmosfery s Ispol'zovaniyem Raket i Sputnikov" Leningrad, Gidrometeorol. Izd., 1966 p 1–363
(NASA-TT-F-390) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Numerous methods of investigating the upper atmosphere by scientific rockets and satellites, including ionosphere sounding probes, meteorological rockets, orbiting geophysical and solar observatories of the U.S.S.R. and United States are described in detail. Underlying physical principles are reviewed, with wiring diagrams and tabulated data given on the instrumentation capsules used. Photographic, telemetry, and onboard television and ground equipment are discussed, with specific reference to achievements of various unmanned and manned satellite and space probe series. Author

N67-19024*# National Aeronautics and Space Administration, Washington, D. C.
IONOSPHERES AND RADIO PHYSICS
E. R. Schmerling *In its* Significant Achievements in Space Sci., 1965 1967 p 17–30 refs (See N67-19022 08-30) GPO: HC $1.00; CFSTI: MF $0.65

Various spacecraft with experiments pertaining to the ionosphere and radio physics are examined. A series of rocket experiments measuring the electron density near sunrise in the lower ionosphere are reviewed, and electron density–height profiles are included. Results of rocket flights during the solar eclipse of July 20, 1963 are presented through electron density profiles. Techniques involving rockets, satellites, and backscatter sounders were used to measure electron temperature in the upper ionosphere. Operation of Alouette I is mentioned, and vlf tools for use in determining ion composition are discussed. Three methods are proposed for tackling the problem of electric fields in the ionosphere experiments to measure potential differences between long insulated booms on spacecraft; the observation of a stream of particles ejected from a satellite; and the separation of a stream of neutral and ionized gases released from a rocket. S.P.

N67-19036*# RAND Corp., Santa Monica, Calif.
THE RELATION BETWEEN THE DIAMETER OF A LIGHTNING STREAMER AND ITS RADIATED RADIO FREQUENCY SPECTRUM
R. L. Kirkwood Jan. 1967 29 p refs
(Contract NASr-21(07))
(NASA-CR-82475; RM-5242-NASA) CFSTI: HC $3.00/MF $0.65 CSCL 04A

An estimate is made of the spectrum radiated by a current streamer whose cross-sectional dimensions are an appreciable fraction of a wavelength and in which the current varies discontinuously with time. If the current distribution is roughly uniform throughout the streamer and drops rapidly to zero at the edge, it is found that the amplitude of the radiated spectrum will decrease inversely as the frequency at frequencies below the one at which the projection of the mean diameter of the streamer in the direction of the observer is about 0.4λ. At higher frequencies the spectrum decreases inversely as the 5/2 power of the frequency. For streamers in which the current varies less abruptly or the edge of the streamer is not so well defined, the spectrum will decrease more rapidly than this at high frequencies. Experimental evidence suggests that the spectrum of lightning decreases inversely as the frequency up to a frequency of at least 500 Mc. If so, it is concluded that either the radiating streamer has an effective diameter of less than 24 cm or that the streamer current is not the major source of radiation at frequencies above a few hundred megacycles. Author

N67-19066# Institut d'Aeronomie Spatiale de Belgique, Brussels.
THERMAL CONDUCTION AND ION TEMPERATURES IN THE IONOSPHERE
Peter M. Banks 1966 19 p refs Submitted for publication
(A-49-1966) CFSTI: HC $3.00/MF $0.65

An analysis of the ion energy balance equation for the ionosphere includes the effects of O^+, He^+, and H^+ ions, thermal conduction, and the cooling by atomic hydrogen and helium. Thermal conduction strongly affects the ion temperature profile for conditions of moderate and low electron densities and the high altitude ion temperature can be significantly less than the electron temperature. In addition, H^+ in concentrations as low as 10% of the total ion density is found to be a major recipient of heat from the ionospheric electron gas, and has an important influence upon the total ion energy budget. Author

N67-19085*# Graduate Research Center of the Southwest, Dallas, Tex.
A MASS SPECTROMETRIC DETERMINATION OF THE COMPOSITION OF THE NIGHTTIME TOPSIDE IONOSPHERE
John H. Hoffman [1966] 20 p refs
(Grant NsG-269)
(NASA-CR-82513) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The concentrations of H^+, He^+ and O^+ were determined as a function of altitude by means of a magnetic mass spectrometer flown on an Argo D-4 rocket at local midnight on January 17, 1964, from Wallops Island, Virginia. The lower ionosphere consists primarily of O^+ with a transition of H^+ as the predominant ion at 430 km. He^+ never becomes the predominant species, its maximum density being $5\times10^3/cm^3$. The temperature calculated from scale heights of the various constituents is $700°\pm100°K$. The neutral hydrogen density at 350 km is calculated, assuming chemical equilibrium between H^+ and O^+, to be $5\times10^6/cm^3$. Author

N67-19093* General Dynamics Corp., San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science.
RESEARCH ON ELEMENTAL ABUNDANCES IN METEORITIC AND TERRESTRIAL MATTER Summary Progress Report, 1 Sep. 1965–30 Sep. 1966
R. A. Schmitt 30 Sep. 1966 35 p refs
(Contract NASw-843)
(NASA-CR-82505; GA-7424) CFSTI: $3.00 CSCL 08D

Abundances of Na, Sc, Cr, Mn, Fe, Co, and Cu were determined by instrumental neutron activation analysis in some 68 specimens of meteorites and 5 terrestrial samples. Results of these analyses

are tabulated along with abundances for these same elements determined by another group in some 75 meteoritic specimens. Also included are tables listing the final mass weighted average abundance in each meteoritic class and the calculated atomic abundance of the final mass weighted average abundance relative to the conventional standard of 10^6 Si atoms; correlation coefficients of six possible pairs of lithophilic elements Na, Sc, Cr, and Mn, and of the three pairs of the three siderophilic elements Fe, Co, and Cu; the final abundance of the seven elements Na through Cu in some 596 individual chondules separated from 28 chondritic meteorites; average abundances of Si in chondrules; and correlation coefficients for Na, Sc, Cr, Mn, and Fe with Si in chondrules. R.N.A.

N67-19097*# Michigan Univ., Ann Arbor. High Altitude Engineering Lab.
HIGH ALTITUDE RADIATION MEASUREMENTS Quarterly Report, 1 Jan.–31 Mar. 1966
Fred L. Bartman Jan. 1967 26 p
(Contract NASr-54(03); ORA Proj. 05863)
(NASA-CR-82489; Rept.-05863-13-P) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Bidirectional reflectance data obtained with the 0.2–4.0 micron channel of the F-4 MRIR on the 10 March, 1965 balloon flight are duscussed. Some of the calibration data of the thermal channels of the F-4 MRIR are presented, illustrating differences between calibrations and variations in calibration data over a 14 month period. The problems arising during the extensive preparation and calibration of the IRIS interferometer for a balloon flight test are described. Author

N67-19100*# Illinois Univ., Urbana. Electrical Engineering Research Lab.
STEADY STATE FLUID MODELS OF THE ION-EXOSPHERE
J. E. C. Gliddon and K. C. Yeh Nov. 1966 58 p refs
(Grant NsG-24)
(NASA-CR-82486) CFSTI: HC $3.00/MF $0.65 CSCL 04A

An ion-exosphere can be defined as the uppermost part of the ionosphere in which the self-collision time is much larger than the time required for ions to travel between mirroring points. The system is entirely controlled by externally applied forces and long-range Coulomb forces. Assuming that the Lorentz force is dominant and that the heat transport is negligible, a closed system of hydromagnetic equations can be derived by taking successive moments of the Vlasov equation. This system of equations is often referred to as the CGL theory, in which the two equations of state are equivalent to the requirement that the magnetic moment and the longitudinal invariant be adiabatic invariants. A magnetohydrostatic solution of the CGL equations is given. The dilute plasma is assumed to be in a gravitational field, permeated by a strong dipole magnetic field and rotating with constant angular velocity about the dipole axis. These equations are solved in the dipole coordinate system by assuming that the ion-exosphere is either in adiabatic equilibrium or in isothermal equilibrium. Analytic expressions for the density, the elements of the pressure tensor, and the temperature of the fluid have been derived. A formula for the ring current has also been found. The results are illustrated by a number of representative curves. Author

N67-19124*# Pennsylvania State Univ., University Park. Ionosphere Research Lab.
CHARGED PARTICLE TEMPERATURES AND ELECTRON THERMAL CONDUCTIVITY IN THE UPPER ATMOSPHERE Scientific Report No. 276
Peter M. Banks 15 Jul. 1966 30 p refs
(Grants NsG-134-61; Nonr(G)-00009-66)
(NASA-CR-82455; AD-640906) CFSTI: HC $3.00/MF $0.65 CSCL 04A

An analysis is made of the effect of electron-neutral particle collisions and an appropriate expression is developed for the electron thermal conductivity which is applicable to a weakly ionized plasma. It is found that a correction term needed to include the effect of neutral particles is of importance during both day and night at all altitudes below 220 km. In fact, at altitudes below 135 km it appears that the conduction term can be neglected in the electron energy balance equation. Using the derived expression for the effective electron thermal conductivity, an example of calculated temperatures characteristic of quiet solar conditions is presented. Author

N67-19142# Sandia Corp., Albuquerque, N. Mex.
ADDITIONAL HUGONIOT DATA FOR GEOLOGIC MATERIALS
Robert C. Bass Oct. 1966 29 p refs
(Contract AT(29-1)-789)
(SC-RR-66-548) CFSTI: HC $3.00/MF $0.65

Hugoniot equation-of-state were obtained for several additional geologic materials. Included were andesite, volcanic breccia, granite, limestone, oil shale, tuff, and alluvium. Author (NSA)

N67-19185# National Physical Lab., New Delhi (India). Radio Propagation Unit.
IONOSPHERIC PREDICTIONS FOR DECEMBER 1966
Sep. 1966 3 p
(RRC-B123) CFSTI: HC $3.00/MF $0.65

Charts showing predicted median foF_2 and MUF(4000)F_2 values in Mc/s for December 1966 (range of latitudes extending from north 80° down through 0° to south 80° vs local time), are presented. A nomogram for transforming F_2-zero-MUF and F_2-4000-MUF to equivalent maximum usable frequencies at intermediate transmission distances is also given, along with a conversion scale for obtaining optimum traffic frequency (FOT). L.S.

N67-19197# National Physical Lab., New Delhi (India). Radio Propagation Unit.
IONOSPHERIC PREDICTIONS FOR JANUARY 1967
Sep. 1966 3 p
(RRC-B124) CFSTI: HC $3.00/MF $0.65

Charts showing predicted median foF_2 and MUF(4000)F_2 values in Mc/s for January 1967 (range of latitudes extending from north 80° down through 0° to south 80° vs local time), are presented. A nomogram for transforming F_2-zero-MUF and F_2-4000-MUF to equivalent maximum usable frequencies at intermediate transmission distances is also given, along with a conversion scale for obtaining optimum traffic frequency (FOT). L.S.

14 INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; and telescopes and cameras.

N67-18217# Consolidated Electrodynamics Corp., Pasadena, Calif.
PIEZOELECTRIC ACCELEROMETER USERS' HANDBOOK
[1966] 24 p

Definition, theory, and application of piezoelectric accelerometers are presented in a user's handbook. Piezoelectric

vibration and shock transducers are described with respect to materials, design, low impedance accelerometers, and charge and voltage amplifiers. Frequency response, temperature effects, the Curie point, and cross axis sensitivity, are all considered in a definition of accelerometers. Finally, specifications for piezoelectric accelerometers, velocity transducers, and electronics, are presented. S.P.

N67-18258# Hewlett-Packard Co., Palo Alto, Calif.
HEWLETT-PACKARD JOURNAL, VOLUME 18, NO. 3
F. J. Burkhard, ed. Nov. 1966 18 p refs

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N67-18259# Hewlett-Packard Co., Palo Alto, Calif.
A SIMPLIFIED DC DIFFERENTIAL VOLTMETER AND RATIOMETER FOR HIGH-PRECISION MEASUREMENTS
Lawrence J. Lopp, Jr. *In its* Hewlett-Packard J., v. 8, no. 3 Nov. 1966 p 2–8 refs (See N67-18258 08-14)

A detailed description is given of a precision solid state instrument capable of measuring dc voltages from below 1 μV to 1100 volts at resolutions of 0.2 parts per million (ppm) and accuracies of 20 ppm over much of this range. Measurements can also be made of resistance and voltage ratios in four ranges from 1 to 0.001 to the same accuracy. The basic components of the instrument include an accurate and stable voltage source, a precision resistance divider, and a low drift, high sensitivity null detection meter. C.T.C.

N67-18260# Hewlett-Packard Co., Palo Alto, Calif.
ADAC–AN AUTOMATIC SYSTEM FOR MEASURING HALL EFFECT IN SEMICONDUCTORS
Egon Loebner, T. J. Diesel, and Cristy M. Schade *In its* Hewlett-Packard J., v. 18, no. 3 Nov. 1966 p 9–16 refs (See N67-18258 08-14)

The complete ADAC system consists of a controller and data acquisition equipment, and a dewar and magnet. The relatively compact system can be supplemented by various data recording means such as card punch equipment. Discussions are given of the Hall effect, automatic data acquisition, operation, and advantages of the ADAC. Included are an analysis of solids with more than one type of carrier, and a study of the electronic transport properties of indium arsenide using the ADAC equipment. C.T.C.

N67-18261# System Development Corp., Santa Monica, Calif.
THE USE OF TEAMS IN IMAGE INTERPRETATION: INFORMATION EXCHANGE, CONFIDENCE, AND RESOLVING DISAGREEMENTS Technical Research Report
George W. Doten, John T. Cockrell, and Robert Sadacca Oct. 1966 29 p refs
(Contract DA-49-092-ARO-65)
(Rept.-1151; AD-643312) CFSTI: HC $3.00/MF $0.65

The report centers on system team interactions designed to reduce the time required for team interpretation while maintaining the superiority of team procedures in the accuracy and completeness of the imagery information extracted. Three experiments were conducted, using the common procedure of having each team member in two-man teams check the interpretation of his teammate. Three specific primary objectives were established: (1) To determine the amount and type of knowledge which the checker should have of the initial interpreters work; (2) To determine whether the initial interpreter can accurately judge when his work needs to be checked by his teammate; and (3) To determine how best to utilize a third man to resolve disagreements among teammates on interpreted items. Variations in procedures were achieved for analysis by setting up four phases or modules of interpreter team activity. Team results produced under each method were assessed in terms of completeness, amount of error, accuracy, and efficiency. Findings suggest that (1) more complete results are produced with higher efficiency in teams where the checker has full knowledge of the initial interpreters work; (2) only limited judgment as to the adequacy of their interpretations can be made by initial interpreters; (3) team performance increases in completeness but decreases in efficiency with the introduction of a third man; (4) results with different team methods pose a tradeoff situation, since no one method appears to hold best for team performance under all requirements. Author (TAB)

N67-18317*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
THIN FILM INFRARED THERMOPILE DETECTORS
D. S. Herman *In its* Space Programs Sum. No. 37-42, Vol. IV 31 Dec. 1966 p 49–51 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

Results are presented of research to improve the responsivity in deposited bismuth–antimony and bismuth tellurium thin film infrared thermopile detectors used in lunar and planetary horizon scanners. The approaches used in achieving greater responsivity in the detectors involved improving the electrical characteristics of present materials, using new materials, and studying the substrate onto which the films were deposited. The capability of the detectors to meet thermal sterilization requirements was also examined. R.N.A.

N67-18333*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
AN ALGORITHM FOR THE SYNTHESIS OF BINARY SEQUENCE DETECTORS
M. Perlman *In its* Space Programs Sum. No. 37-42, Vol. IV 31 Dec. 1966 p 139–146 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

The detection of a given 31-bit pseudorandom sequence was extended to the detection of any given n-place binary sequence within a data stream. The sequence detector is defined as an electronic combination lock which is opened for one digit period only when the proper sequence of binary digits is entered. The constraint is delineated, and a 10-bit sequence that does not satisfy this condition is given as an example. Cyclic permutation, and prefix coding of the original sequence are discussed as ways of satisfying the constraint. Detection methods are listed as shift register and decisional element, and sequential network with a minimum number of memory elements. An algorithm for determining the number of memory elements and an optimal state assignment for detecting a given sequence is formulated. Its use would permit a logic designer to (1) synthesize a detector for an n-bit sequence with r memory elements where $1+[\log_2 n] \leq r \leq n-1$; and (2) select an n-bit sequence for any given value of n such that its detector can be synthesized with $1+[\log_2 n]$ memory elements. M.G.J.

N67-18342*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
A MAGNETIC RECORDING TAPE LAYER-TO-LAYER ADHESION TESTER
W. G. Clement *In its* Space Programs Sum. No. 37-42, Vol. IV 31 Dec. 1966 p 176–179 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

Details are given on the design and construction of a test apparatus for evaluating the interlayer adhesion problem, and for determining the relative susceptibility of various tapes in this phenomenon. The concept is based on the idea that as the pack is rotated in a direction to unspool the tape, the free end will break away from the pack at some point between west (tangent, no adhesion) and south (radial, maximum adhesion), depending on the weight used and the degree of adhesion existing. The geometry involved is shown, and the derivation of the peel force from the measurements made is given. Eight different tapes were tested at several time–temperature soak combinations. Peel forces measured ranged from 0.042 to 2.490 oz. It is concluded that this extreme variation in layer-to-layer adhesion indicates the importance of evaluating this characteristic before committing any tape to a flight program involving the use of a reel-to-reel transport. M.G.J.

N67-18366# Southampton Univ. (England). Inst. of Sound and Vibration Research

THE HOT WIRE ANEMOMETER

P. O. A. L. Davies and M. R. Davis Oct. 1966 52 p refs

(ISAV-155) CFSTI: HC $3.00/MF $0.65

The anemometer consists of a fine electrically heated wire which is cooled by the flow being measured. There are two basic methods of hot wire operation: In one the current through the wire is maintained constant and resistance changes are measured, which is the constant current anemometer. Alternatively, the wire resistance is maintained constant by a servo-amplifier and the subsequent changes of heating current are measured. This is the constant temperature or constant resistance anemometer. An understanding of hot wire operation requires a knowledge of the steady and unsteady convective heat transfer between a heated wire and a fluid flow, a knowledge of the techniques of hot wire probe manufacture and measuring configurations and a knowledge of the operation, calibration and performance of practical systems. These are considered in the order stated. ESRO

N67-18367# Royal Observatory, Edinburgh (Scotland). Satellite Tracking Section.

KINETHEODOLITE TRACKING

Bennet Mc Innes 14 Oct. 1966 8 p refs

(Rept.-58) CFSTI: HC $3.00/MF $0.65

A general description of a typical cinetheodolite is given, its use explained, and a typical tracking operation depicted. Design modifications for satellite tracking (e.g. operation through a control unit to reduce repetition rate of record frames on cine film, photovisual technique, larger sighting telescope, photoelectric recording and instrumental corrections to achieve positional and timing accuracy) are described. The paper concludes with the advantages of cinetheodolites like the divided circle reference system, the speedy re-setting and complete freedom of movement as well as the altazimuth mount. ESRO

N67-18533# California Univ., Livermore. Lawrence Radiation Lab.

DEVELOPMENTS IN MAGNETOSTRICTIVE READOUTS FOR SPARK CHAMBERS

Victor Perez-Mendez Sep. 1966 4 p refs Presented at the Intern. Conf. on Instrumentation for High Energy Phys., Stanford, Calif., 1966

(Contract W-7405-ENG-48)

(UCRL-17121; CONF-660918-4) CFSTI: HC $3.00/MF $0.65

A review is presented on some of the performance characteristics and some of the more recent developments in magnetostrictive readouts for wire chambers developed at LRL. NSA

N67-18546* Northwestern Univ., Evanston, Ill.

A PATROL OF THE LUNAR SURFACE WITH A 24-INCH REFLECTOR AND IMAGE ORTHICON SYSTEM Semiannual Status Report, 1 Jun.–30 Nov. 1966

J. Allen Hynek 30 Nov. 1966 11 p

(Grant NsG-597)

(NASA-CR-82013) CFSTI: $3.00 CSCL 03A

The lunar patrol program activities, a comparison with the Moon Blink and Argus Astro-net programs, and the equipment and facilities are described. The meteorological conditions are mentioned, and the red-blue blink patrol, concurrent infrared observations, and visual observations of the earthlit portion after new moon are reviewed. Areas where surface activity was systematically patrolled each night include Aristarchus, Alphonsus, and Copernicus. It was felt that with respect to instrumentation, location, library, and maintenance and repair facilities, the Corralitos observatory offers greater capability than other programs. N.E.N.

N67-18547*# IIT Research Inst., Chicago, Ill.

ABSOLUTE PRESSURE TRANSDUCER CALIBRATION DEVICE Final Report

D. F. Parnet Jul. 1966 75 p refs

(Contract NAS8-11915)

(NASA-CR-82012; IITRI-M6123) CFSTI: HC $3.00/MF $0.65 CSCL 14B

An instrument has been developed to calibrate high intensity, high frequency transducers. The device consists of two horn-driver units and a generator, which generate sound pressure levels in an acoustic cavity of between 140 and 175 dB in the frequency range 500 cps to 40 kcps, together with an optical interferometer using a helium neon laser source. The acoustic cavity is located in one of the two beams of a Michelson interferometer. The sound field in the cavity produces a temporal variation in the optical interference distribution. This variation is monitored with a photodiode detector. The magnitude and phase of the sound pressure field in the cavity can be determined by a simple method of signal processing enabling the pressure sensitivity as well as the phase characteristics of transducers to be determined. Using this instrument, the sensitivity of a 1/4 in. condenser microphone was determined. The results agreed to better than 1/2 dB with those of a pistonphone calibration. Author

N67-18611# Institute of Radiation Physics, Helsinki (Finland).

AN ALGOL PROGRAMME FOR THE DETECTION EFFICIENCIES AROUND A CYLINDRICAL SCINTILLATION CRYSTAL

O. Castren Sep. 1966 17 p refs

(SFL-A5)

A computer program is presented by which it is possible to study the distribution of the detection efficiency around a cylindrical scintillation crystal and to calculate detection efficiencies of large volume samples. The program takes into account attenuation in the sample, crystal shield and the wall of the sample container. It was written specifically for a sample container surrounding the crystal, an arrangement generally used in the measurement of environmental samples in health physics. In addition to the complete program, the general mathematical principles and detailed explanations of the program are presented. The program was written for an Elliott 503 computer equipped with a core backing store. Author (NSA)

N67-18617# Joint Inst. for Nuclear Research, Dubna (USSR).

CORRECTION OF PULSE HEIGHT SPECTRA WITH THE HELP OF DIGITAL COMPUTERS [KORREKTSIYA AMPLITUDNYKH SPEKTROV S POMOSHCH'YU TSVM]

G. I. Zabiyakin, V. I. Prikhod'ko, V. G. Tishin, and L. P. Chelnokov 1966 10 p refs
(JINR-P-2851)

A method of correction of pulse height spectra with the help of digital computers is described. Author (NSA)

N67-18820# Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Engineering and Science.
INEXPENSIVE MULTI-CHANNEL TIME ANALYZER
Ralph R. Fullwood [1966] 8 p
(Contract AT(30-1)-328)
(TID-23392) CFSTI: HC $3.00/MF $0.65

An inexpensive 128 channel pulse height analyzer was equipped with a time digitizer which operates in increments ranging from 0.5 μsec to 256 μsec per channel. This in no way interferes with the original ability of the analyzer to switch selectably in Mössbauer, multiscaling, or pulse height modes. The system also features oscilloscope display, printed and punched paper tape output at a total equipment cost of $5500. Author (NSA)

N67-18840*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
NIMBUS 1 AUTOMATIC PICTURE TRANSMISSION (APT) TV-CAMERA SYSTEM
Aug. 1966 31 p refs
(NASA-TM-X-55669; X-730-66-394) CFSTI: HC $3.00/MF $0.65 CSCL 14E

The automatic picture transmission (APT) system, designed for real-time broadcast of daytime meteorological television pictures, was flown on Nimbus A (designated Nimbus 1 on achievement of orbit), the first of a series of meteorological satellites launched August 28, 1964, at the Western Test Range (WTR), Vandenberg Air Force Base, California. During the 371-orbit active lifetime of Nimbus 1 (August 28 to September 24, 1964), the APT system performance was highly satisfactory and response from the scientific community around the world was enthusiastic. The APT system transmitted 6999 minutes of video (about 2000 pictures) to APT ground stations throughout the world. The present paper is a general description of the Nimbus 1 APT system with a detailed analysis of APT camera performance in flight as illustrated in pictures received by the APT ground stations. Author

N67-18869 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
APPLICATION OF ATOMIC CLOCKS TO LOCALIZATION PROBLEMS [APPLICATION DES HORLOGES ATOMIQUES AUX PROBLEMES DE LOCALISATION]
R. Moreau *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 15–16 (See N67-18861 08-34) CFSTI: $3.00

Atomic clocks as highly stable frequency standards are mentioned for possible use onboard space vehicles to determine the position of a vehicle in space, as well as the time on any point of the Earth. Summarized basic research is listed under the trichotomy: (1) characteristics of various types of atomic clocks; (2) utilization of atomic clocks for trajectography; and (3) theory and experiments on synchronization procedures for several time devices in various locations. Transl. by R.Ll.

N67-18897*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE MERITS AND SHORTCOMINGS OF A MICHELSON TYPE INTERFEROMETER TO OBTAIN THE VERTICAL TEMPERATURE AND HUMIDITY PROFILE
R. A. Hanel and L. Chaney (Mich. Univ., Ann Arbor) Oct. 1966 10 p refs
(NASA-TM-X-55678; X-620-66-476) CFSTI: HC $3.00/MF $0.65 CSCL 20F

The scientific objectives, instrument requirements, calibration, and advantages and disadvantages of a Michelson interferometer for the Nimbus meteorological satellite are discussed. The operation of the interferometer is described, and a schematic diagram is included. The advantages include its multiplex property, or Felgett advantage, and the large product of the collecting area and the solid angle of acceptance. The following disadvantages are outlined, as well as possible solutions: (1) The spectrum is not directly accessible but requires a Fourier transformation of the interferogram. (2) Interferometers require stability of the target radiation during the recording period of an interferogram. (3) Compared to conventional radiometers, the tolerances of optical alignment are very critical. (4) The accuracy required can only be achieved by a very large dynamic range (2000:1) in the data channel. Finally, preliminary results of a breadboard model of an interferometer, which was built and tested in the laboratory and flown on a high altitude balloon, are reported. L.E.W.

N67-18735*# General Electric Co., Johnson City, N. Y. Avionic Controls Business Section.
RESEARCH TO DEVELOP AND DEFINE CONCEPTS FOR RELIABLE CONTROL SENSORS—THE SOLID STATE RATE SENSOR Final Report
W. D. Gates, S. B. Hamilton, and J. J. Wilszynski Apr. 1966 76 p refs
(Contract NAS12-25)
(NASA-CR-80008) CFSTI: HC $3.00/MF $0.65 CSCL 14B

The solid state rate sensor consists of a free–free beam supported at its nodal points and vibrating in one plane at its fundamental bending frequency. It senses angular rate by detecting the presence of Coriolis forces. Piezoelectric crystals are bonded to the metallic beam and provide the driving force which vibrates the beam at its fundamental frequency. Similar crystals provide the readout of the Coriolis induced vibration. This report describes the development design, fabrication and test of the solid state rate sensor. Significant advancements have been made in the state-of-the-art, particularly in the areas of crystal-beam bonding, vibration amplitude regulation, and elimination of coupling between the drive and readout axis. Author

N67-18890# California Univ., Livermore. Lawrence Radiation Lab.
DEVELOPMENT OF AN IMPROVED GAMMA-RAY DETECTOR OF THE MOXON-RAE TYPE
S. F. Eccles, C. E. Frerking, and P. B. Snow 23 Aug. 1966 12 p refs
(Contract W-7405-ENG-48)
(UCRL-50126) CFSTI: HC $3.00/MF $0.65

A detector of the Moxon-Rae type having multiple gamma ray-to-electron converter plates was developed to give improved efficiency for detecting gamma rays. Lucite was chosen for the converter material over a number of other materials considered. The gamma ray efficiency of the detector was calibrated and found to be linear with gamma ray energy in the range from 663 keV to 7.73 MeV. The neutron sensitivity of the detector was also measured and found to be generally small compared to the gamma ray sensitivity. Preliminary neutron-capture cross section data in the upper electron volt range on gold indicates that the detector works well in this application. Author (NSA)

N67-18919* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A GLANCING INCIDENCE SOLAR TELESCOPE FOR THE SOFT X-RAY REGION

J. H. Underwood and W. S. Muney Sep. 1966 32 p refs
(NASA-TM-X-55671; X-614-66-420) CFSTI: $3.00 CSCL 03A

The instrumentation of an Aerobee rocket, launched to observe the sun in the soft X-ray region, is described. The experiment package, which was pointed at the sun by a control system stabilized about all three axes, carried two Wolter type I glancing incidence telescopes to photograph the sun in wavelength regions (determined by bandpass filters) between 3 and 75 Å, and two proportional counters to obtain flux data and rough spectral shapes in the regions 2 to 11 Å and 8 to 20 Å. The spatial resolution obtained was about 20 arc seconds. Limb brightening and polar darkening are very pronounced at the longer wavelengths. A tuft of emission was observed at the North Pole in addition to an arch-like structure on the NW limb. Several photographs are presented, and some preliminary results are discussed. Author

N67-18920*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A TELESCOPE SUITABLE FOR ROCKET BORNE INSTRUMENTATION
Patrick H. Verdone Nov. 1966 12 p
(NASA-TM-X-55689; X-614-66-523) CFSTI: HC $3.00/MF $0.65 CSCL 03A

Details are given on the telescope which was part of the instrumentation package in experiments to photograph the sun in the near ultraviolet (Mg II, λ 2802.7 Å). The commercially available unit selected was a Maksutov–Cassegrain type telescope, chosen because it combines a very compact, closed construction with high resolution, a long effective focal length, and excellent imaging qualities. The optical system is discussed, and the modifications which were necessary in the mechanical, thermal, and vacuum systems are described. The final telescope was mounted on a baseplate to be flown on an Aerobee 150 solar pointed experiment. After being flown and recovered, the experiment package was checked for focus and alignment of the telescope, neither of which had changed. It is pointed out that instantaneous G loading on the payload at the time of main parachute deployment is between 15 and 30 G. It is also reported that the payload was flown a second time with the telescope performing equally as well. M.G.J.

N67-18928*# National Aeronautics and Space Administration, Washington, D. C.
RESOLUTION AND MICROPHOTOMETRIC GRANULARITY OF INFRARED FILMS [RAZRESHAYUSHCHAYA SPOSOBNOST'I MIKROFOTOMETRICHESKAYA ZERNISTOST'INFRAKRASHYKH PLENOK]
I. I. Breydo Jan. 1967 4 p refs Transl. into ENGLISH from Zh. Nauch. i Prikled. Fot. i Kinematografii (Moscow), v. 11, Jan.–Feb. 1966 p 59–60
(NASA-TT-F-10864) CFSTI: HC $3.00/MF $0.65 CSCL 14E

Results of an experimental investigation of the resolving power of several photographic infrared films. Measurement with a resolvometer revealed that the resolution is strongly dependent on the frequency of the incident light, being about twice as high for violet as for red light. A check of these results using the contact method confirmed the original findings. Possible mechanisms for this effect are discussed. Author

N67-19014# Oak Ridge National Lab., Tenn.
A FABRY–PEROT DUOCHROMATOR FOR THE MEASUREMENT OF SMALL WAVELENGTH DISPLACEMENTS OF SPECTRAL LINES
Joseph G. Hirschberg and Walter I. Fried Nov. 1966 18 p refs
(Contract W-7405-ENG-26)
(ORNL-4019) CFSTI: HC $3.00/MF $0.65

A two-channel duochromator was constructed utilizing the high luminosity and dispersion of the Fabry–Perot interferometer. The duochromator was tested by measuring the Zeeman effect of a singlet line in the spectrum of helium. Its sensitivity to small wavelength shifts was initially determined to be about 7 parts in 10^9. Author (NSA)

N67-19017* Radio Corp. of America, Princeton, N. J. Astro-Electronics Div.
MODIFICATION OF THE TIGRIS IMAGE-ORTHICON CAMERA SYSTEM Final Report
W. Sensenig and R. Schmid 16 Dec. 1966 53 p refs
(Contract NASw-1342)
(NASA-CR-82670; AED-R-3118) CFSTI: HC $3.00/MF $0.65 CSCL 14E

An improved high-sensitivity, image-orthicon television camera system, developed under the TIGRIS program (Televised Images of Gaseous Regions in Interplanetary Space), is presented. Advanced electronic components were incorporated; an investigation of shading, automatic-exposure control, and black halation was made, and recommendations based on the results of the investigation prepared. An electronic shutter was developed that will permit continuously variable exposure times over the range of 125 milliseconds to 16 seconds. Additional magnetic shielding was added for acceptable performance in a 2-gauss peak-to-peak magnetic field. Typical applications for this camera include observation of star-fields, night cloud cover, star-illuminated scenes, and gaseous regions in space. The camera application is also noted for recording spectrometric data, and, if used in conjunction with image converters, it can be used for recording low-level X-ray radiation or obtaining thermal pictures. R.U.

N67-19119*# Louisiana State Univ., Baton Rouge. Dept. of Physics and Astronomy.
A WIDE-RANGE MULTI-INPUT PULSE HEIGHT RECORDING SYSTEM
Russ Humphreys [1966] 23 p refs
(Grant NGR-19-001-012)
(NASA-CR-82658) CFSTI: HC $3.00/MF $0.65 CSCL 14C

This paper describes a system which can photographically record with one dual-beam oscilloscope the amplitudes of 10 simultaneous photomultiplier pulses over a four-decade dynamic range with an accuracy of ±1.5% over the entire range. The signal processing time is 2.2 μsec. The basic circuit is logarithmic pulse-height-to-time converter with two triggering levels, requiring twelve transistors per input channel. The dynamic range of the device could be easily extended to six decades, and the two-level technique can be applied to digitalized recording systems and pulse height analyzers. The circuit has been built and has been found to meet the above specifications over a temperature range from 0°F to 100°F. Author

N67-19137* Metrophysics, Inc., Santa Barbara, Calif.
PORTABLE PROTOTYPE TUBE FLARE INSPECTION INSTRUMENT. PHASE I: DESIGN Progress Report, 1 Jul.–1 Dec. 1965
6 May 1966 221 p Addendum included
(Contract NAS8-20516)
(NASA-CR-82442) CFSTI: HC $3.00 CSCL 14B

This report covers the design phase for the development of a portable tube flare inspection instrument. The design work includes circuit design, mechanical design, probe and fixture design, and breadboarding to prove design feasibility. These objectives have been met successfully, and work is proceeding on fabrication and documentation. Author

N67-19177# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
THE DETECTION OF TRITIUM IN AIR WITH IONIZATION CHAMBERS
R. V. Osborne and G. Cowper Oct. 1966 22 p refs
(AECL-2604) CFSTI: HC $3.00/MF $0.65

Monitors for detecting tritium in air in the presence of gamma radiation were made by mounting, coaxially, a sealed ionization chamber inside an ionization chamber which can sample the surrounding air. The effective volume of the outer chamber is equal to that of the sealed chamber and only the difference in current from the pair of chambers is measured. In this way as much as 98% of the gamma contribution to the ionization current in the outer chamber can in practice be cancelled out. An area monitor has 40 / ionization chambers and portable monitors have 1.2/ or 0.3/ ionization chambers. The sensitivity of the area monitor can normally be switched from 0–1.5 $(MPC)_a$ tritiated water vapor up to 0–500 $(MPC)_a$. Further extension by two decades is possible. The most sensitive ranges on the portable monitors are 0–10 $(MPC)_a$ and 0–45 $(MPC)_a$ respectively, and both can be switched over two decades with five ranges. Sampling rates are high enough for the response times of the monitors to be less than one minute. Author

N67-19238# Rocky Flats Div., Dow Chemical Co., Golden, Colo.
ROCKY FLATS CONTINUOUS AIR MONITOR
R. A. Kirchner, V. R. Griep, and W. M. Hartzell 2 Nov. 1966 7 p refs
(Contract AT(29-1)-1106)
(RFP-815) CFSTI: HC $3.00/MF $0.65

A reliable and inexpensive (less than $400) continuous air monitor was developed. The air monitor, an alpha scintillation device, continuously monitors air samples collected on 47-mm filter paper. A readout is provided by a transistorized rate meter and an adjustable meter relay. The meter relay actuates an alarm when a preset amount of activity is collected on the filter paper. An outlet plug is provided for a recorder if one is desired. Based on a radioactivity concentration guide (RCG) of 9 dpm/M^3, the continuous air monitor is capable of identifying as little as 1 RCG-day and alarming at this amount. At Rocky Flats the instrument is usually set to alarm at approximately 3 RCG-days above natural background radiation. Numerous instruments are located throughout plutonium-handling areas and employ a warbling alarm as an indication that respiratory protection is required. Author (NSA)

N67-19244*# Wyle Labs., Huntsville, Ala. Testing Div.
A TECHNIQUE FOR THE DYNAMIC CALIBRATION OF HOT WIRE ANEMOMETERS
R. C. Potter Jul. 1966 50 p refs
(Contract NAS8-11312)
(NASA-CR-82591; WR-66-29) CFSTI: HC $3.00/MF $0.65 CSCL 14B

A technique for dynamically calibrating hot wire anemometers is examined. The wire is mounted on the end of a cantilever beam, which is driven at its natural frequency of vibration by an electromechanical shaker. The wire is positioned in the laminar core of subsonic cold jet. The output signal is compared to a value calculated from the static calibration of the wire, when the wire is held still in a steady air flow, and the measured frequency and displacement of the wire. The output voltage shows a more sharply peaked signal than obtained for the calculated values from the static calibration. It is suggested that at low mean velocities, in rarefield atmospheres, and in supersonic flows, the inertia of the viscous flow field over the wire could become significant and cause the convective heat transfer process of change from the static calibration example. Thus, the dynamic calibration technique becomes extremely useful. Author

N67-19266# Deutsche Versuchsanstalt für Luft- und Raumfahrt, Munich (West Germany). Institut fuer Physik der Atmosphaere.
INVESTIGATION OF THERMISTORS [UNTERSUCHUNGEN AN THERMISTOREN]
H. P. Barthelt, K. Kugler, R. Roth, H. Willeke Apr. 1966 75 p refs In GERMAN; ENGLISH summary
(DLR-FB-66-72) CFSTI: HC $3.00/MF $0.65

The physical properties of various types of thermistors are investigated. The sensor with the best capability for temperature measurement at great heights is determined. Thermal inertia and radiation-caused temperature exceeses are studied in detail. Some problems of thermistor technology are discussed. Author

N67-19327# Oak Ridge National Lab., Tenn.
RADIATION DETECTOR STUDIES (1)
In its Neutron Phys. Div. Sep. 1966 p 60–68 refs (See N67-19321 08-22) CFSTI: HC $3.00/MF $0.65

Brief summaries are given of the development of an epithermal neutron spectrometer; design of a highly sensitive, isotropically responding fast-neutron dosimeter; development of instrument-response unfolding methods; and neutron spectrometry with bulk liquid organic scintillators. NSA

N67-19359* Lockheed Missiles and Space Co., Palo Alto, Calif. Research Lab.
NEUTRON MULTIPLICITY MONITOR OPERATIONS AT SEA LEVEL AND 3800 METER ELEVATION Final Report, 22 Jun. 1965–22 Jun. 1966
R. A. Nobles, R. A. Alber, E. B. Hughes, L. L. Newkirk, G. T. Reynolds et al 22 Jun. 1966 91 p refs
(Contract NASw-1240)
(NASA-CR-82597) CFSTI: $3.00 CSCL 14B

The neutron multiplicity monitor, a unique type of cosmic ray neutron monitor designed for the efficient exploitation of the energy dependence of multiple neutron production, is described. Operating deep in the atmosphere, its purpose is to obtain information on the energy spectrum of the incident secondary cosmic radiation. This monitor differs from the ordinary type because of its higher intrinsic efficiency (i.e., it counts a larger fraction of the internally produced neutrons), and its greater target thickness allows operation more nearly as a total energy detector. It also has electronic circuitry for multiplicity measurements. This monitor is unique in that it gives intensity information similar to an ordinary monitor and, in addition, yields information on energy spectrum variations. R.U.

15 MACHINE ELEMENTS AND PROCESSES

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control, and reliability; drafting; and materials fabrication, handling, and inspection.

N67-18274# Gt. Brit. Ministry of Aviation, London.
NONDESTRUCTIVE TESTING OF METAL–ADHESIVE BONDS WITH ULTRASONIC PULSE ECHO INSTRUMENTS [DIE ZERSTOERUNGSFREIE PRUEFUNG VON METALKLEBVERBINDUNGEN MIT ULTRASCHALL-IMPULS-GERAETEN]
W. Althof Aug. 1966 79 p refs Transl. into ENGLISH from German
(TIL/T-5680) CFSTI: HC $3.00/MF $0.65

Metal-to-metal bonds and bonding of cover plates of honeycomb constructions were tested. Several test methods were used: testing by reflection of Lamb waves, and testing with combined transmitter–receiver head using reflection techniques. Flaws in the bond layer, variable thickness of adhesive and porosity of adhesive layers were clearly shown. Over- or under-curing of the adhesive was not shown by the results; variations in the adhesive between component and adhesive layer were not shown. Author

N67-18609* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
ADHESION IN THE SPACE ENVIRONMENT
H. E. Pattee and R. E. Monroe Huntsville, Ala., Redstone Sci. Inform. Center, 31 Oct. 1966 149 p refs Prepared by Battelle Mem. Inst. Sponsored jointly by Army Missile Command
(Contract DA-01-021-AMC-14693(Z))
(NASA-TM-X-59395; RSIC-607) CFSTI: HC $3.00 CSCL 13H

This report presents a comprehensive literature survey of adhesive bonding (cold welding) in the space environment. Space characteristics are summarized and experimental methods for reproducing these conditions are investigated. Information is particularly directed towards electronics and the metals used for electrical contacts. A total of 124 references are cited along with a selected bibliography of 44 citations. Author

N67-18608# Los Alamos Scientific Lab., N. Mex.
DESIGN, DEVELOPMENT, AND FABRICATION OF MULTICAVITY 805 MHZ ACCELERATOR TANKS
H. G. Worstell 7 Sep. 1966 21 p Presented at the Linear Accelerator Conf., Los Alamos, N. Mex.
(Contract W-7405-ENG-36)
(CONF-661021-11; LA-DC-8247) CFSTI: HC $3.00/MF $0.65

The development of full scale 805 Mc tank models for the proposed LAMPF accelerator is discussed. Topics included are materials, machining, joining techniques, allowable stresses (especially at elevated temperatures), quality control, heat transfer, and the provision of an evacuation system capable of maintaining a good clean high vacuum under full power operation. NSA

N67-18676 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
ONERA THERMO-CHEMICAL TECHNIQUE OF PROTECTION AND ASSEMBLAGE OF STEEL AND REFRACTORY ALLOYS [TECHNIQUES THERMO-CHIMIQUES ONERA DE PROTECTION ET D'ASSEMBLAGE DES ACIERS ET ALLIAGES REFRACTAIRES]
Ph. Galmiche *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 27–28 (See N67-18661 08-34) CFSTI: $3.00

Significant industrial application of effective solutions to the steel and refractory metal problems in the fabrication of supersonic engines and ramjets are reported. This conference outline provides some technical details on thermochemical methods of chromization, chromoaluminization, and tantalization. Brazing and annealing techniques for aerospace application are also very briefly mentioned. Transl. by R.Li.

N67-18683*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
A PERFORMANCE INVESTIGATION OF AN EIGHT-INCH HUBLESS PUMP INDUCER IN WATER AND LIQUID NITROGEN
Charles D. Miller and Loren A. Gross Washington, NASA Mar. 1967 25 p ref
(NASA-TN-D-3807) CFSTI: HC $3.00/MF $0.65 CSCL 13K

The pump inducer was tested in conjunction with a shrouded centrifugal impeller, which approximates the configuration found in rocket engine propellant pumps. Testing was begun using de-ionized water with a nominal flowrate of 2400 gpm at 6500 rpm and was increased in 200-gpm increments to 4000 gpm while holding the speed constant. All tests were started with a minimum NPSH of 60 ft, which diminished with the decrease in liquid level and tank pressure. Results are graphed for both water and liquid nitrogen tests. Analysis of the water data indicated the cavitation performance of the inducer was at least equal to the state-of-the-art over a wide operating range, but with lower pump efficiency and developed head than expected. The liquid nitrogen data were slightly lower than expected with respect to lowering NPSH requirements, but did increase efficiency. The critical NPSH, or NPSH, at 2% head loss, appeared dependent upon the inducer to casing clearance. N.E.N.

N67-18942*# Midwest Research Inst., Kansas City, Mo.
COLD MOLECULAR WELDING STUDY Quarterly Report, 15 Sep.–15 Dec. 1966
Vern Hopkins 23 Jan 1967 6 p refs
(Contract NAS9-3623; MRI Proj. FS-132-E)
(NASA-CR-65593; QR-2) CFSTI: HC $3.00/MF $0.65 CSCL 13H

Beryllium–copper pellets were cold welded on 321 stainless steel wear plates in studies to obtain a better understanding of cold welding evaluation techniques. Results are presented in tabular form for three investigations: (1) the reproducibility of test results under identical experimental conditions, (2) a comparison between sliding tests in ultra-high vacuum, dry air, and ambient air, and (3) the effect of alternate sliding and resting of metal couples for two sliding durations between stops. A brief interpretation of the results based on visual observations is also included. A.G.O.

N67-19012# Mechanical Technology, Inc., Latham, N. Y.
AN EXPERIMENTAL STUDY OF FLOW PHENOMENA IN THE FEEDING REGION OF AN EXTERNALLY PRESSURIZED GAS BEARING
J. H. Vohr 21 Jul. 1966 56 p refs
(Contract Nonr-3730(00))
(MTI-65TR-47; AD-637877) CFSTI: HC $3.00/MF $0.65

The report describes some measurements made of film entrance losses for a circular, externally pressurized, gas bearing under subsonic flow conditions. The nature of the flow in the entrance region was studied by means of pressure profile measurements. Measurements were made of the recovery of pressure downstream of an orifice discharging into the bearing feeding hole and of the influence of this orifice on film entrance pressure loss. The significance of these various phenomena on bearing performance was demonstrated by an illustrative calculation for a typical bearing. Author (TAB)

N67-19032*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
VALVES AND VALVE PROBLEMS
A. Perkins [1966] 39 p
(NASA-TM-X-53419) CFSTI: HC $3.00/MF $0.65 CSCL 13K

Various problems encountered in the design, manufacturing, and testing phases of valves for aerospace applications are discussed. The manufacturing phase and failure evaluation are considered in detail. Examples are given of valve failures and the corrective action taken, and the creation and operation of a valve clinic to repair, reservice, and modify all vehicle valves that are not returned to the vendor are described. L.E.W.

N67-19052*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
A PORTABLE DIFFERENTIAL BALL GAUGE TO MEASURE THE INTERNAL FLARE ANGLE OF MC 148 FLARED TUBING
David Cleghorn, William A. Wall, and J. D. Bennight 5 Dec. 1966 44 p ref
(NASA-TM-X-53548) CFSTI: HC $3.00/MF $0.65 CSCL 13I

The internal angle of MC 148 Revision D flared tubing is specified as 74°±1-1/2°. This angle is critical for correct mating with the male flare fitting. A considerable amount of effort has been expended for quality control purposes to measure this angle by a plaster or plastic cast method. Techniques to measure this angle are usually time consuming and costly. A portable differential ball gauge to measure the internal flare angle accurately and speedily is described. The operational theory and pertinent mathematical derivations are included to demonstrate the principles of design of the internal flare angle guage MR&T-sk-872. Potential error sources are discussed in order to evaluate their theoretical and practical impact on total accuracy. Tables and charts are included to short cut the design time of future ball gauges. It is concluded that the differential ball gauge concept is a practical shop and inspection instrument which will quickly determine the average internal tube flare angle without waiting or relying heavily on operator judgement. Author

N67-19067*# Hittman Associates, Inc., Baltimore, Md.
THERMOELECTRIC BONDING STUDY Phase III Summary Report
Abraham L. Eiss Nov. 1966 55 p refs
(Contract NAS5-3973)
(NASA-CR-82528; HIT-237) CFSTI: HC $3.00/MF $0.65 CSCL 13H

Results of life tests of braze bonded lead telluride elements are presented. Tests of 21 n-PbTe and 33 p-PbTe elements bonded to iron shoes with SnTe-Ti braze were completed, with the longest runs being 5900 hours for the n-type material and 3570 hours for p-PbTe. Hot junction temperature was held at 950°–1000°F during these runs. Electron microprobe studies were performed on a number of n- and p-type elements. The most significant observation was that tin diffuses extensively from the braze into the lead telluride and that this diffusion is similar for both types of material. The depth to which the tin penetrates increases with test time, but the rate of increased penetration decreases with time. Studies confirmed earlier results showing that small molybdenum and tungsten additions can significantly strengthen p-PbTe, with molybdenum being particularly effective. Several 1000 hours life tests demonstrated that tungsten powder or wire and molybdenum wire have no detrimental effect on the performance of p-PbTe. Excessive initial degradation was observed in elements containing the molybdenum additive in powder form. Longer tests of samples containing molybdenum wire additives confirmed that the behavior of such elements is comparable to unmodified p-PbTe. S.P.

N67-19080# National Research Council of Canada, Ottawa (Ontario). Fuels and Lubricants Lab.
COMPARATIVE LABORATORY PERFORMANCE OF AIR BRAKE CYLINDER LUBRICANTS
L. D. New and B. I. Patterson Aug. 1966 15 p ref
(NRC-9296; MP-43) CFSTI: HC $3.00/MF $0.65

A test method for measuring the low temperature release time and the high temperature cup wear preventive properties of air brake cylinder lubricants is described. The results of comparative trials of reference and various proprietary lubricants are given. A non-soap thickened polyglycol grease containing MoS_2 was best at 150°F, and proprietary products gave acceptable performance at both temperature levels. The relationship between composition and performance of the air brake cylinder lubricants tested is noted. Author

N67-19155*# Studebaker Corp., Cincinnati, Ohio. CTL Div.
DEVELOPMENT OF AN ANALYTICAL TECHNIQUE FOR PREDICTING PROPERTIES OF COMPOSITE MATERIALS, PART II Final Report, Jul. 1, 1964–Feb. 1, 1966
R. E. Silbernagel and R. A. Wise 28 Feb. 1966 135 p ref
(Contract NAS8-11036)
(NASA-CR-82485) CFSTI: HC $3.00/MF $0.65 CSCL 13H

Physical, thermal, and optical properties of composite material constituents were determined so as to completely characterize the material. Actual experimental data on the performance of the composite material under a preselected radiant heating environment were established. Three potential materials design systems were examined: (a) the pure conventional ablator system, (b) the combined heat sink, transpiration cooling system, or Pyro-Convective Cooling (PCC) system, and (c) the dual density ablator impregnated with a transpiration cooling system. The environment chosen was that experienced by a multi-pulsed, uncooled rocket motor such as was programmed for ullage and attitude control motors. Based upon selected composite material characterizations for each of the three systems, predictions of material composition satisfying the chosen environment were made. Schematic models and theoretical equations were developed for the PCC combined heat sink, transpiration cooling system, and the dual density ablator, impregnated system. Author

N67-19161# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
TECHNIQUES FOR HOT-PRESS-BONDING DISSIMILAR METAL COMBINATIONS
R. D. Watson May 1966 20 p ref
(AECL-2583) CFSTI: HC $3.00/MF $0.65

High strength diffusionless bonds can be produced in a variety of dissimilar metal combinations by the hot press bonding technique covered by Canadian Patent application 904,548 June 6, 1964. Some of the combinations that can be joined successfully are Zircaloy-2 and 416 stainless steel, 416 stainless steel and mild steel, 1S aluminum and mild steel, Zircaloy-2 and M257 SAP, and Zircaloy-2 and 1S aluminum. Several other combinations were attempted but suitable joints could not be produced. The methods of producing the joints, the joint strength that can be developed and a discussion of some of the problems associated with making the joints are included in the report. Author

N67-19166 Lockheed Missiles and Space Co., Palo Alto, Calif.
COMPLEX LOADING MACHINE WITH AUTOMATIC PROGRAMMING OF THE STRESS STATE
B. D. Annin, N. S. Danilov, and Iu. N. Rabotnov [1966] 2 p refs Transl. into ENGLISH from Mekh. Tverdogo Tela (USSR), no. 6, 1966 p 161–162

A description is given of a machine intended to test thin-walled tubular samples under the simultaneous effect of a tensile force and a torque. The machine is generated on the basis of the CH machine previously described. However, in contrast to the latter, the automatic programming is realized in the force and the moment. The maximum axial force is 5000 kg, and the maximum torque is 5000 kg cm. Author

N67-19274*# Boeing Co., Seattle, Wash. Aerospace Group.
STUDY OF DISSIMILAR METAL JOINING BY SOLID STATE WELDING Final Report

C. H. Crane, R. T. Torgerson, D. T. Lovell, and W. A. Baginski 1 Oct. 1966 199 p refs
(Contract NAS8-20156)
(NASA-CR-82460) CFSTI: HC$3.00/MF$0.65 CSCL 13H

Investigations were conducted to (1) study the solid state welding of six dissimilar alloy combinations by press and roll diffusion welding and to establish the influence of major processing variables upon diffusion phenomena, and (2) determine the characteristics of diffusion welded joints between six dissimilar metal combinations. The influence of the primary diffusion parameters (time, temperature, and pressure) and of the process variables (surface preparation, atmosphere, and diffusion aid materials) were studied on the following six diffusion couples: (1) 2219 aluminum alloy to 321 stainless steel, (2) 7106 aluminum alloy to 321 stainless steel, (3) 2219 aluminum alloy to Ti-5Al-2.5Sn titanium alloy, (4) 321 stainless steel to Ti-8Al-1Mo-1V titanium alloy, (5) 321 stainless steel to Inconel 718 alloy, and (6) Inconel 600 to Ti-8Al-1Mo-1V titanium alloy. Metallurgical analyses were performed to follow element migration, to identify the compositions of the diffusion zones, and to determine the influence of thickness and hardness of the diffusion zones on the properties of the joint. additional studies were made on the effect of material condition (heat treatment and strain hardening) on diffusion welding. The most promising diffusion welding techniques were further identified by metallurgical evaluation, mechanical and thermal shock testing, leak testing, and by corrosion studies. The joining techniques which were determined to be the most promising were further analyzed by a theoretical projection of the diffusion welding process for production applications. Author

N67-19360* North American Aviation, Inc., Los Angeles, Calif.
DEVELOPMENT OF NONDESTRUCTIVE TESTING TECHNIQUES FOR HONEYCOMB HEAT SHIELDS. VOLUME II: LITERATURE, INDUSTRIAL SURVEY, AND BIBLIOGRAPHY
G. Martin, J. F. Moore, and J. W. Rocke 31 Aug. 1966 168 p refs
(Contract NAS8-11733)
(NASA-CR-82619; NA-66-912) CFSTI: $3.00 CSCL 13H

A literature and industrial survey of pertinent nondestructive testing techniques and equipment was conducted in support of a development program for nondestructive testing of honeycomb heat shields. Literature relating to ultrasonic, electromagnetic, radiographic, and other methods of nondestructive testing was collected, reviewed, and indexed. A partially annotated bibliography of pertinent literature was prepared and included with the reported survey results. The literature and industrial surveys, in addition to the contractor's conducted effort, were evaluated and formed the basis for the experimental nondestructive test development program. R.Li.

16 MASERS

Includes applications of masers and lasers. For basic research see: 26 Physics, Solid State.

N67-18270# Stanford Univ., Calif. Dept. of Aeronautics and Astronautics.
MEASUREMENT OF THE VELOCITY DISTRIBUTION FUNCTION OF A GAS USING A LASER
Krishnamurty Karamcheti, Sotiris P. Koutsoyannis, Munson A. Kwok, and Maurice L. Rasmussen May 1966 78 p refs
(Contract Nonr-225(61))
(SUDAAR-275; TR-1; AD-638795) CFSTI: HC$3.00/MF$0.65

The problems associated with the measurement of the velocity distribution function of a gas using a laser are presented and discussed. A simple theoretical model relating the frequency variation of the absorption coefficient across a spectral line of a gas to the distribution function of velocities in the direction of propagation of a plane monochromatic wave is developed and applied to measurements of attenuation of a laser beam passing through the gas. Experimental results with a d.c. excited neon gas and a He–Ne laser oscillating at 6328.2 Å show that under certain experimental conditions agreement with theory is good. Author (TAB)

N67-18448*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
LASER REFLECTIONS FROM THE BEACON EXPLORER SATELLITES
Henry H. Plotkin [1965] 30 p refs Submitted for Publication
(NASA-TM-X-57166) CFSTI: HC$3.00 CSCL 20E

Two satellites have been supplied by the Goddard Space Flight Center with arrays of cube-corner reflectors, and have been used as orbiting targets for ruby laser radiation. The observed intensity of reflected radiation is in agreement with theory. Although the distribution of the reflected light is affected by target geometry and atmospheric fluctuations, qualititative agreement was found with calculations of velocity aberration due to the satellite's motion. The system has been used to determine satellite range. R.Li.

N67-18668 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
APPLICATIONS OF LASERS TO AEROSPACE STUDIES [APPLICATIONS DES LASER A DES ETUDES AEROSPATIALES]
C. Veret *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 13–14 (See N67-18661 08-34) CFSTI: $3.00

The optical properties of lasers for aerospace technology are briefly evaluated in this conference paper. Time and space coherence of light emissions from various lasers were studied, and light impulses from ruby lasers were applied to telemetry procedures. Pulsed or continuous lasers were found to improve interferometer performance in wind tunnels due to their improved visualization capability of aerodynamic flow. Another application cited is the use of lasers in making trajectographies of a body in free fall for weightlessness studies. Transl. by R.Li.

N67-18747*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
MASER SPIN DYNAMICS
Harold A. Sabbagh Sep. 1966 24 p refs
(NASA-TM-X-55676; X-523-66-448) CFSTI: HC $3.00/MF $0.65 CSCL 20E

Since masers are electronic devices that operate on quantum mechanical principles, new techniques must be employed for analysis of their performance. This paper attempts to present mathematical tools for the analysis of maser spin dynamics. A simple mathematical model of a maser spin system is employed to show how the frequency response characteristics (i.e., the absorption spectrum) of a maser spin system may be calculated. Then some significant parameters that determine those characteristics are pointed out. Although the analysis is general, some of the results are applied to a specific spin system: triply ionized iron-doped rutile. Author

N67-18935# National Aeronautics and Space Administration, Washington, D. C.
DRAG EFFECT OF THE ACTIVE MEDIUM OF A GAS RING LASER [EFFET DE L'ENTRAINEMENT DU MILIEU ACTIF D'UN LASER A GAZ EN ANNEAU]
Dario Pecile and Edmond Batifol Jan. 1967 6 p Transl. into ENGLISH from French Presented at the Acad. Sci. Paris, 8 Aug. 1966
(NASA-TT-F-10893) CFSTI: HC $3.00/MF $0.65 CSCL 20E

A study was made of the beat frequency F between the oscillations corresponding to the two directions of travel in a ring laser cavity, when the gas discharge column constituting the active medium was in motion. The phenomenon, involving the dispersion of the active medium, should help to explain the operation of the laser. On the other hand, the experiment affords a method for shifting the zero of a laser gyroscope. This procedure does not require the introduction of solid elements into the cavity. Author

N67-19095*# Varian Associates, Beverly, Mass.
DEVELOPMENT AND CONSTRUCTION OF TWO HYDROGEN MASERS Interim Technical Report, 1 Feb. 1962–31 May 1963
K. Vessot 30 Jan. 1964 61 p refs
(Contract NAS8-2604)
(NASA-CR-82491) CFSTI: HC $3.00/MF $0.65 CSCL 20E

Optimal construction of two atomic hydrogen frequency standards was studied by combining lightweight, small size, and improved stability of the cavity and bulb structure in dielectrically loaded quartz spheres each, about 8 inches in diameter. The first parts designed included the mounting frame, vacuum manifold, and the general pump layout, as well as the hexapole magnet assembly and its mounting hardware. Size, weight, and power requirements of the low vacuum scavenger pumps of the differentially pumped maser system was reduced by using outgassed titanium hydride sorption techniques and a source collimator to reduce the flux of atoms in the off-axis direction. Measurements data on the relative stability of these two masers, as well as on their stability as measured via external communications were included. G.G.

N67-19096* Honeywell, Inc., St. Paul, Minn. Research Dept.
EXPERIMENTAL RESEARCH ON CRITICAL PROBLEMS ASSOCIATED WITH THE LASER INTEGRATING GYRO Final Report, 1 Jul. 1965–30 Jun. 1966
Frederick Aronowitz and Harry Gustafson 31 Jul. 1966 132 p
(Contract NAS12-27)
(NASA-CR-82490; Rept.-12018) CFSTI: $3.00 CSCL 20E

The effects of mode coupling due to scattering effects in a traveling wave He–Ne ring laser are investigated, both theoretically and experimentally. A Lamb-type calculation is made in which the effects of scattering are treated as source terms in Maxwell's equations. This results in a scattering correction to the self-consistent equations. The scattering correction to the single mode amplitude equations result in mode competition between the oppositely directed beams and possible extinction of one of the beams. The scattering correction to the frequency equations produces frequency synchronization between the oppositely directed beams. Experimental varification of both effects is given. Author

N67-19130* Korad Corp., Santa Monica, Calif.
LASER GYRO BALANCER Final Report
H. P. Popick 24 Oct. 1966 12 p
(Contract NAS8-20585)
(NASA-CR-82449) CFSTI: HC $3.00 CSCL 20E

A laser system has been designed and built to dynamically balance gyro rotors and statically balance accelerometers. The laser system is comprised of a power supply, laser head, focusing cone, water cooler, and remote control console. Criteria for selection of the laser system are given, and design principles including energy requirement, optical requirement, and electronics requirement analyses are discussed. Charts summarizing the weight changes of several different metals after laser irradiation are also included. A.G.O.

N67-19224# Massachusetts Inst. of Tech., Cambridge.
INVESTIGATION OF THE USE OF MASERS IN THE INFRARED AND OPTICAL REGIONS Final Report, 1 Mar. 1964–31 Aug. 1966
Ali Javan and Charles H. Townes 30 Sep. 1966 21 p refs
(Contract AF 19(628)-4011)
(AFCRL-66-727; AD-644626) CFSTI: HC $3.00/MF $0.65

Contents: gas laser research: interaction of an intense laser beam with matter. TAB

N67-19235# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
DETERMINATION OF LOSSES IN A RUBY LASER WITH A DISADJUSTED RESONATOR
V. A. Pilipovich, L. A. Bogdanovskaya, and V. I. Lebedev 28 Sep. 1966 9 p refs Transl. into ENGLISH from Zh. Prikl. Spektroskopii (USSR), v. 4, no. 3, 1966 p 236–239
(FTD-HT-66-492; TT-67-60333; AD-644169) CFSTI: HC $3.00/MF $0.65

A method is proposed for determining the losses in a ruby laser with a disadjusted resonator. It is shown that the probability method formula for generation energy correctly describes the dependence of generation energy upon the angle between the resonator mirrors if the experimental value of the losses is put into this formula. Author (TAB)

17 MATERIALS, METALLIC

Includes cermets; corrosion; physical and mechanical properties of materials; metallurgy; and applications as structural materials. For basic research see: 06 Chemistry. For related information see also: 18 Materials, Nonmetallic; and 32 Structural Mechanics.

N67-18207# Lockheed Missiles and Space Co., Palo Alto, Calif.
INVESTIGATION OF THE TRANSFORMATION INTO THE SOLID STATE IN ALLOYS OF THE TITANIUM–ZIRCONIUM SYSTEM
V. V. Kuprina, V. B. Bernard, A. T. Grigor'ev, and E. M. Sokolovskaia [1966] 5 p refs Transl. into ENGLISH from Vestn. Mosk. Univ., Ser. III: Khim. (Moscow), no. 5, 1966 p 69–73

The properties of titanium–zirconium alloys were studied after various heat treatments in order to determine phase transformation. Alloy structures were studied in the cast, homogenized, quenched, and annealed states. Examinations included microscopic and X-ray analyses, hardness and micro-hardness tests, and high-temperature thermal analyses. Data and illustrations of hardness and microstructure are presented, and a phase diagram is included. K.W.

N67-18214# Rock Island Arsenal Lab., Ill.
ANALYSIS OF CHIP FORMATION CHARACTERISTICS OF 18% NICKEL MARAGING STEEL
George F. Wilson [1966] 25 p refs Presented at the CIRP Ann. Assembly, Paris, Sep. 1966

The machining characteristics of 18% nickel–300,000 psi ultimate tensile strength grade maraging steel were investigated. Some of the important geometrical and mechanical properties of chip formation for this material were compared with AISI 4340 steel. It was found that the cutting force was lower and the friction and thrust forces were higher for the 18% Ni maraging steel as compared with the AISI 4340 steel. The shear angle is slightly lower while the mean shearing strain is correspondingly higher for the maraging steel. The specific power consumption is somewhat less for the maraging steel than it is for the medium carbon low alloy steels of similar hardness level. The greatest difficulty in machining this material can be attributed to its ductility: the chip is difficult to break and a large burr is usually produced. Author

N67-18321*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
CERAMIC RESEARCH
M. H. Leipold *In its* Space Programs Sum. No. 37-42, Vol. IV 31 Dec. 1966 p 63–64 ref (See N67-18301 08-34) CFSTI: HC$3.00/MF$0.65

The capabilities of the load measuring equipment of a mechanical testing facility are briefly described. Results of modulus measurements made with the load measuring subsystem are shown and indicate the system's capability to measure small stresses and strains accurately. R.N.A.

N67-18464# Cornell Univ., Ithaca, N. Y.
ELASTIC CONSTANTS OF METALLIC SODIUM
Riho Hans Martinson (Ph.D. Thesis) 17 May 1966 145 p refs
(Contract AT(30-1)-2504)
(NYO-2504-15) CFSTI: HC$3.00/MF$0.65

The variation with temperature and pressure of the velocity of 10-Mc elastic waves propagating in monocrystalline metallic sodium was studied. The pressure dependence was measured at 78°, 195°, 273°, and 299°K to pressures ranging from 4.5 to 9 kilobars. At atmospheric pressure, measurements of the temperature dependence extended from 78° to 299°K. Although the dependence of the adiabatic elastic constants on the intensive thermodynamic variables is substantially linear throughout much of the domain investigated, small nonlinearities were observed at low temperatures and at the higher pressures. The observed values of the athermal second order elastic constants of sodium agree fairly well with Fuchs' theoretical predictions, although the direct ion core interactions in metallic sodium appear to be somewhat larger than those pertinent to the sodium halides. Experimentally accessible combinations of the third order elastic constants of sodium have been calculated by a simple extension of the method of Wigner and Seitz. Fair agreement is obtained at 0°K with the extrapolated experimental values. Author (NSA)

N67-18478# Centre National de la Recherche Scientifique, Paris (France).
[PREPARATION AND PROPERTIES OF STAINLESS STEELS] Quarterly Report, 1 Apr.–30 Jun. 1966
G. Chaudron 30 Jun. 1966 21 p
(Contract EURATOM-059-65-7 TEEF (RD))
(EUR-2868; EURAEC-1678; QR-14) CFSTI: HC$3.00/MF$0.65

The effects of C concentration on the properties of austenitic stainless steels of 18-10 type were studied. Alloys with 18% Cr, 12% Ni, and various C contents were prepared. The steels involved are respectively a, steel containing 20 ppM C, b, steel with 80 ppM C, and c steel with 600 ppM C. The mechanical properties of these alloys were determined by measuring the Vickers hardness as well as by recording the tensile curves for wires; the presence of C causes an increase of the elastic limit and the ultimate tensile strength of the steels. The effects of C on the corrosion of austenitic stainless steels were investigated. Particular attention was directed toward corrosion by pitting in ferric chloride; intergranular corrosion by dechromization, revealed by $CuSO_4$ reagent; and intergranular corrosion in boiling HNO_3 with addition of hexavalent Cr. NSA

N67-18477# Atomic Energy Commission, Washington, D. C. Div. of Technical Information.
HARDENING OF SAP/Al_2O_3 ALLOYS AT LOW TEMPERATURES
P. Guyot and R. Debeir [1966] 26 p refs Transl. into ENGLISH from Acta Met., v. 14, 1966 p 42–55
(AEC-TR-6808)

The hardening of SAP has been studied at low temperatures. The analysis of tensile curves, the determination of activation energy and of activation volumes show that the mechanism of deformation is a thermally activated intersection of the dislocations in the Al matrix. The density of dislocations is high, being of the order of $10^{11}/cm^2$; owing to the indirect action of the alumina particles it increases rapidly vs the plastic deformation, thus leading to high strain hardenings. This hardening at high temperatures is not due to any atomic impurities. Author (NSA)

N67-18523# Centre d'Etude de l'Energie Nucleaire, Mol (Belgium).
IMPERFECTIONS IN METALS. II: CORROSION AND OXIDATION
31 Mar. 1966 14 p refs
(Contract EURATOM-054-64-4 TEEB)
(EURAEC-1701; EUR-2889; R-2384; QR-14) CFSTI: HC $3.00/MF$0.65

The defect structure caused by mechanical working of stainless steel surfaces was investigated by electron microscopy in transmission. A high density of dislocations was observed which is in agreement with the model proposed elsewhere for the enhanced corrosion resistance caused by such treatments. The precipitation at the grain boundaries of chromium carbides in steel type AISI 304 was studied by the same technique. The precipitation treatments were performed either during the observation in the electron microscope or in a furnace. It was found that no defect structure, caused by the precipitation, is visible near the grain boundaries. A similar mechanism as was proposed for the mechanically deformed surfaces cannot account for the zones of improved corrosion resistance along the grain boundaries. Author (NSA)

N67-18524# Centre National de la Recherche Scientifique, Paris (France).
[PREPARATION AND PROPERTIES OF STAINLESS STEELS] Quarterly Report, Jan. 1–Mar. 31, 1966
G. Chaudron 31 Mar. 1966 13 p Transl. into ENGLISH from French
(Contract EURATOM-059-65-7(F))
(EURAEC-1642; EUR-2841; QR-13) CFSTI: HC$3.00/MF$0.65

Methods used in preparation of 18-10 stainless steel containing controlled quantities of C are described. The C was added as Fe–C with 1.8% C using vacuum melting. Steels containing several hundred ppM C were prepared. Investigations of stress corrosion testing of stainless steel revealed that reagents generally used in these tests contain traces of $Mg(ClO_3)_2$ which decomposes yielding

Cl_2 upon heating. The free Cl_2 may lead to faulty corrosion test results. Results of investigation concerning the effects of Ni content on the mechanical properties of stainless steel containing 19% Cr are reported. The Ni content was varied between 5 and 14%. It was found that 14% Ni content is required for production of stable austenitic structure in this alloy. NSA

N67-18586# General Electric Co., Cincinnati, Ohio. Nuclear Technology Dept.
IRON–CHROMIUM–ALUMINUM–YTTRIUM ALLOY FOR ELECTRICAL HEATING ELEMENTS
H. R. Stephan and J. F. Collins 18 Oct. 1966 7 p
(Contract AT(40-1)-2847)
(GEMP-440) CFSTI: HC$3.00/MF$0.65

Accelerated life tests of an Fe–25Cr–4Al–1Y alloy (GE-2541) conducted at 2200°F show this alloy containing Y to have superior life to that of a similar commercial Fe–19Cr–4Al alloy without Y. The GE-2541 alloy had an average life to burnout of 350 hours, (compared to 292 hours for the commercial alloy), only a slight increase in resistivity, and less than 4 percent elongation. Furthermore, the GE-2541 alloy forms an adherent oxide coating which restricts spalling when thermal cycled. These initial test data indicate this alloy has greater potential as high temperature heating elements than present commercial alloys. Author (NSA)

N67-18587# Oak Ridge National Lab., Tenn.
JOINING OF TUNGSTEN
R. G. Gilliland Oct. 1966 20 p
(Contract W-7405-ENG-26)
(ORNL-TM-1606) CFSTI: HC $3.00/MF $0.65

A cursory investigation was made of the use of various joining methods on W fabricated by several techniques. W produced by powder metallury, arc-casting, thermochemical deposition (TCD), and molten-salt bath plating was used as the base metal. The joining processes were (1) gas W-arc fusion welding (TIG), (2) gas W-arc braze welding, (3) electron-beam welding, (4) thermochemical deposition joining, and (5) high-temperature brazing. Testing of the various welded joints included three-points bending to determine ductile-to-brittle transition temperatures (DBTT). All joints, both welded and brazed, were evaluated metallographically to assess their general integrity and quality. From this study it was found that the welding of W can be successfully accomplished in a number of different ways, and the use of postjoining thermal treatments can often improve the ductility of the joints. Stress relieving of TIG welds in vacuum in powder metallurgy W for 1 hr at 1800°C reduces the DBTT by approximately 100°C. Gas tungsten-arc welds in TCD material show a 200°C improvement in transition temperature after a vacuum stress relief of 1 hr at 1000°C. These welds exhibited the lowest DBTT (235°C). The use of another filler metal to braze-weld W caused an impairment of joint properties, rather than an improvement, when compared with other welding processes. It was found that all types of W could be successfully brazed using alloys from the Ta–V–Nb and Ta–V–Ti ternary systems. Author (NSA)

N67-18595# Brussels Univ. (Belgium). Faculté des Sciences.
INVESTIGATION INTO SOME PROBLEMS OF METAL OXIDATION Quarterly Report, 1 Apr.–30 Jun. 1966
30 Jun. 1966 11 p Transl. into ENGLISH from French
(Contract EURATOM-079-64-10 TEEB(RD))
(GR-2; EURAEC-1675; EUR-2866) CFSTI: HC$3.00/MF$0.65

In all cases the crystals formed by controlled oxidation of solid Al belong to the compound γAl_2O_3. The form of the nuclei varies with the orientation of the metal with which they are in epitaxic relation, despite the existence of an amorphous layer at the start. The aspect of the crystals formed by iodination of Cu is strongly dependent on the temperature of the reaction. The phenomenon always seems to be different on either side of the crystallographic transformation points in CuI. Author (NSA)

N67-18598# Iowa State Univ. of Science and Technology, Ames.
PACK CARBURIZATION OF IRON UNDER VACUUM CONDITIONS
George Charles Carter (M.S. Thesis) Jul. 1966 94 p refs
(Contract W-7405-ENG-82)
(IS-T-106) CFSTI: HC$3.00/MF$0.65

Samples of Fe and Fe alloys have been tested for pack carburization under vacuum conditions at 950°C employing various kinds of C. The type of C employed is a critical factor; sugar carbon, graphite, and diamond have produced very good cases while a number of other carbons have given essentially no carburization in a four-hour period. The type of Fe employed is also a major factor in determining the success or failure of low-pressure pack carburization. Low-carbon steel and carbonyl iron readily absorb C from sugar carbon and from graphite. Armco iron, wrought iron, and electrolytic iron show little or no carburization in any carbon pack. Acetylene carbon failed to carburize any of the irons. A number of alloying elements have been shown to have marked effects on the carburization of Fe in a pack under vacuum conditions. Experiments have been performed with precision-machined steel samples and solid block graphite to obtain carburization data on contact and near-contact conditions for the metal and C. Results from these experiments together with considerations from previous observations have demonstrated that low-pressure pack carburization is not dependent on a gas phase but is accomplished only through physical contact between the C and Fe. Carbon saturation values were found to have a dependence on the kind of C and Fe employed. Author (NSA)

N67-18675 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
FRITTING OF REFRACTORY MATERIALS [FRITTAGE DE MATERIAUX REFRACTAIRES]
A. Hivert *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 25–26
(See N67-18661 08-34) CFSTI: $3.00

Refractometric studies of high-temperature fusion of metal carbides are briefly exposed. Residual porosity and theoretical density in relation to calcination of these refractory materials are assayed. Residual porosity of 30% was observed in frits of fine powdered carbides of tantalum, titanium, and zirconium which permitted establishing the traction resistance curve as a function of temperature for each of the three refractory compounds. Transl. by R.Li.

N67-18695*# Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.
DETERMINATION OF THE WELDABILITY AND ELEVATED TEMPERATURE STABILITY OF REFRACTORY METAL ALLOYS Quarterly Report, 21 Dec. 1965–20 Mar. 1966
G. G. Lessmann and D. R. Stoner 20 Mar. 1966 80 p refs
(Contract NAS3-2540)
(NASA-CR-72073; NANL-PR-(P)-011; QR-11) CFSTI: HC $3.00/MF$0.65 CSCL 11F

The weldability of three tungsten alloys, including W-25Re, unalloyed W, and Sylvania "A" (W-0.5Hf-0.02C), was determined. All were evaluated as 0.035-inch sheet. Both W and W-25Re were converted from arc cast ingot whereas Sylvania "A" is a powder metallurgy product. Only nominal weldability was realized in these systems even with preheating to 550°F. All had poor

weld ductility as demonstrated by high ductile-to-brittle transition temperatures. Only a minimal recovery of ductility was realized by post-weld annealing. The effect of oxygen contamination on weld strength was determined at room and three elevated temperatures for T-111, T-222, and FS-85. The relationships of fracture mode and location, strength, and ductility with respect to thermal history over a wide oxygen contaminating range (to 1000 ppm) were determined and compared. All alloys are sensitive to contamination and, yet, demonstrated an impressive tolerance. Author

N67-18742*# Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.
EVALUATION OF REFRACTORY/AUSTENITIC BIMETAL COMBINATIONS Third Progress Report, Dec. 22, 1965–Jun. 22, 1966
R. W. Buckman, Jr. and R. C. Goodspeed 22 Jun. 1966 51 p refs
(Contract NAS3-7834)
(NASA-CR-72150; WANL-PR(EE)-003) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Evaluation of the bond integrity of explosively bonded refractory/austenitic bimetal composites continued as five of the six diffusion annealing runs were completed. Inter-diffusion zone thickness of the annealed specimens, as determined metallographically, indicated that the composites could be grouped into three classes depending on the extent of reaction. Specimens of the nine previously selected combinations were thermally cycled. No indications of unbonding were observed. Room temperature tensile testing of specimens which were thermally exposed for 1600 hours at 1500°F indicated that the heat treatment resulted in appreciable decreases in strength and increases in elongation as compared to the as-bonded condition. Creep rupture testing of bimetal composites in the as-bonded condition was initiated. Author

N67-18875# Mallinckrodt Chemical Works, Weldon Spring, Mo. Uranium Div.
SOME OBSERVATIONS ON THE ELECTRON METALLOGRAPHY OF URANIUM Topical Report
H. C. Kloepper, Jr. 1 Aug. 1966 63 p refs
(Contract W-14-108-ENG-8)
(MCW-1501) CFSTI: HC $3.00/MF $0.65

Metallographic techniques are described that are necessary in the preparation of thin-foil specimens of U metal suitable for study at high magnification with the transmission electron microscope. Also discussed are the relations between structure revealed in electron microscopy and X-ray-diffraction data generated from the same area by the electron beam. Application of these techniques to three beta-quenched, alpha-annealed U–Si alloys disclosed that precipitation of U_3Si did not occur within reasonable annealing times at 500°C or less but that precipitation readily took place at dislocation sites when annealed at 600°C, the number and size of particles increasing with annealing time. The U_3Si particles were needle-shaped with a preferred orientation to the U matrix. Other studies of structures of a U–Si alloy after tensile testing indicated that the deformation at room temperature was by twinning whereas at 500°C the metallic flow was mainly by slip. Author

N67-18888# Mallinckrodt Chemical Works, Weldon Spring, Mo. Uranium Div.
THE BETA-TO-ALPHA TRANSFORMATION CHARACTERISTICS OF SOME DILUTE URANIUM ALLOYS
M. F. Nolan 1 Aug. 1966 32 p refs
(Contract W-14-108-ENG-8)
(MCW-1506) CFSTI: HC $3.00/MF $0.65

Equipment is described for isothermal quenching of thin U alloy samples from either β or γ phase temperatures into a molten metal bath at selected α temperatures. TTT diagrams are presented for four alloys ranging from U–Si and U–Al binaries to Fe–Si–Al–Cr alloys. Two modes of transformation are reported as the general case, that in the upper temperature region being a diffusion-controlled nucleation and growth mechanism, and that at lower temperatures acting by shear. An intermediate nose is reported for a centrifugally cast high-Al alloy; in this region the transformation appeared to be by a combination of shear and diffusion. Quenching this same alloy from the gamma phase yields a TTT diagram with only a single nose; transformation at this nose appeared again to be a mechanism of mixed shear and diffusion. Author (NSA)

N67-18914# Oak Ridge National Lab., Tenn.
THE POSSIBILITY OF IRRADIATION DAMAGE AFFECTING THE RATE-CONTROLLING MECHANISM FOR SLIP IN BODY-CENTERED CUBIC METALS AND SOLID SOLUTIONS
R. J. Arsenault Aug. 1966 12 p refs
(Contract W-7405-ENG-26)
(ORNL-3993) CFSTI: HC $3.00/MF $0.65

Most of the experimental data obtained from irradiated body-centered-cubic metals indicate that the rate-controlling mechanism is not changed by the irradiation damage. If these results are considered in terms of previous experimental results from unirradiated body-centered-cubic metals and the theory of thermally activated deformation, the reason for the absence of a change can be explained. However, if the Peierls' stress of a body-centered-cubic metal were reduced, as by alloy addition, then the probability of the irradiation damage affecting the rate-controlling mechanism would increase. Author (NSA)

N67-18915# Battelle-Northwest, Richland, Wash.
IMPROVED POSTIRRADIATION STRESS–RUPTURE PROPERTIES OF HASTELLOY X-280
I. S. Levy Jul. 1966 12 p refs
(Contract AT(45-1-1830)
(BNWL-231) CFSTI: HC $3.00/MF $0.65

Stress–rupture specimens of Hastelloy X-280, a solution-hardenable nickel-base alloy, were given various experimental preirradiation thermomechanical treatments. The specimens were subsequently irradiated at 540°F to exposures of approximately 1×10^{20} nvt (E>1 MeV) and 3×10^{20} nvt thermal. When compared to a standard treatment, some experimental treatments increased postirradiation rupture life up to 106%, with no change in postirradiation minimum creep rate. These treatments increased duration of postirradiation secondary creep up to 115% and increased the duration of postirradiation tertiary creep up to 107%. Property improvements are interpreted based on the interaction of the microstructure formed by the preirradiation treatments with the neutron environment and subsequent thermal and stress environments associated with the testing. Relationships of these results to reactor material fabrication are considered. Author (NSA)

N67-18925*# National Aeronautics and Space Administration, Washington, D. C.
PHASE-DIAGRAM STRUCTURE OF THE TITANIUM–COPPER SYSTEM [STROYENIYE DIAGRAMMY SOSTOYANIYA SISTEMY TITAN–MED]
V. N. Yeremenko, Yu. I. Buyanov, and S. B. Prima Jan. 1967 14 p refs Transl. into ENGLISH from Poroshkovaya Met., Akad. Nauk Ukr. SSR (Kiev), no. 6(42), Jun. 1966 p 77–87
(NASA-TT-F-10661) CFSTI: HC $3.00/MF $0.65 CSCL 11F

The phase diagrams of the titanium–copper system were studied by metallographic, thermographic, X-ray and micro-hardness analyses at concentrations of 20 to 100 at. % Cu. The results and the data in the literature enabled the authors to construct a phase diagram of the Ti–Cu system. In this system, six metallides exist, of which Ti_2Cu, TiCu, and $TiCu_4$ form phases of variable composition with narrow regions of homogeneity. Author

N67-18929*# National Aeronautics and Space Administration, Washington, D. C.

INCREASE OF COHESIVE STRENGTH OF METALLIC COATINGS BY MEANS OF A PRELIMINARY PASSIVATION [POVYSHENIYE PROCHNOSTI STESEPLENIYA METALLICHESKIKH POKRYTIY S POMOSHCH'YU PREDVARITEL'NOY PASSIVATSII]

L. I. Kadanek, A. Kh. Masik, F. M. Peregudov, and Ya. Kh. Bakalyuk Jan. 1967 6 p refs Transl. into ENGLISH from Zh. Prikl. Khim. (Moscow), v. 39, no. 9, 1966 p 1956–1959
(NASA-TT-F-10666) CFSTI: HC$3.00/MF$0.65 CSCL 11F

The results of a quantitative investigation of the influence of passivation on the cohesive strength of metallic coatings are presented. Data on the effect of passivation on the cohesive strength of hot coatings are also given. Author

N67-18937*# National Aeronautics and Space Administration, Washington, D. C.

COLD-ROLLED AND RECRYSTALLIZATION TEXTURES OF MOLYBDENUM SINGLE CRYSTALS

Pang-Hsin Chou Feb. 1967 13 p refs Transl. into ENGLISH from Wu Li Hsueh Pao (Peking), v. 19, no. 5, 1963 p 296–305
(NASA-TT-F-10714) CFSTI: HC$3.00/MF$0.65 CSCL 11F

The cold-rolled and recrystallization textures of molybdenum single crystals were investigated after a reduction in thickness of 70, 80 and 85 percent. As the reduction in thickness increased from 70 to 85 percent the recrystallization textures gradually changed orientations. These results can be satisfactorily explained by oriented nucleation. Author

N67-18983*# Stanford Research Inst., Menlo Park, Calif.

STUDY OF GROWTH PARAMETERS FOR REFRACTORY CARBIDE SINGLE CRYSTALS Quarterly Status Report, Sep. 1–Dec. 1, 1966

R. W. Bartlett 9 Jan. 1967 21 p refs
(Contract NASr-49(19))
(NASA-CR-82466; Rept.-11; QSR-11) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Mixed solid solution boules have been grown with 40% hafnium carbide/60% tantalum carbide and 20% hafnium carbide/80% tantalum carbide starting powders. These boules were polycrystalline. There was little change in metal ratio for the 20/80 composition, but the hafnium content of the 40/60 composition reduced to 35% of the total metal content. For both compositions the carbon content was reduced to approximately 45 at. %. A few long hafnium carbide boules were grown with large single crystal sections, as determined by X-ray diffraction. These boules were grown at rapid rates, 5–10 cm/hr, and contain subgrain boundaries. Several modifications to equipment and operating procedures were made to improve the quality of tantalum carbide boules. Preliminary analyses indicate that the carbon content of tantalum carbide boules has not been increased over that obtained in 10% H_2/90% Ar gas mixture using previous operating practices. Author

N67-19003# Stanford Univ., Calif. Dept. of Materials Science.

STUDIES ON CRYSTALLINE IMPERFECTIONS IN METALS Final Report, Mar. 1, 1963–Feb. 28, 1965

Robert A. Huggins Jun. 1966 23 p refs
(Contract Nonr-225(34))
(SU-DMS-66-16; AD-637774) CFSTI: HC$3.00/MF$0.65

The research program was initiated in order to study the problem of the mechanism or mechanisms by which dispersions of a stable second phase affect the deformation and annealing behavior of metals. In addition to studies directly associated with dispersions, a number of other investigations were conducted relating to various other aspects of the behavior of crystalline imperfections in metals. The significant results are indicated very briefly by reference to previous Technical Reports, papers published in the general technical literature, and Ph.D. dissertations that were either partially or wholly supported by this contract. Copies of the abstracts of the papers and the dissertations are appended. Author (TAB)

N67-19006# Mallinckrodt Chemical Works, Weldon Spring, Mo. Uranium Div.

URANIUM TEXTURE EVALUATION STUDIES, 1963–1966

William C. Stooker and James W. Starbuck 1 Aug. 1966 42 p refs
(Contract W-14-108-ENG-8)
(MCW-1504) CFSTI: HC$3.00/MF$0.65

Sampling procedures permitting appraisal of axial and circumferential textures are assessed and employed in studies of alloy content versus mode of cooling from beta phase heat treatment. Oil quenching or isothermal transformation at about 500°C yield the most random structures in extruded core blanks. An automated diffractometer provides texture values that are equivalent in precision to manually generated data. Circumferential texture variance within centrifugally cast core blanks is associated with the appearance of grain clusters in the macrostructure and may be minimized by isothermal transformation at the upper nose of the TTT diagram for the alloy involved. Author (NSA)

N67-19019# Mallinckrodt Chemical Works, Weldon Spring, Mo. Uranium Div.

PHASE STUDIES OF THE URANIUM–IRON–SILICON TERNARY SYSTEM WITH THE ELECTRON MICROPROBE

R. G. Schierding and L. A. Fergason 1 Aug. 1966 17 p refs
(Contract W-14-108-ENG-8)
(MCW-1502) CFSTI: HC$3.00/MF$0.65

The solubility limits of Fe and Si in the U allotropes and in the intermetallic phases U_6Fe and U_3Si were determined by electron microprobe analysis. The allotropic transformation temperatures were determined by differential thermal analysis. The U-rich portion of the U–Fe binary phase diagram is presented along with isothermal sections of the U-rich corner of the U–Fe–Si ternary system. Author (NSA)

N67-19033*# Case Inst. of Tech., Cleveland, Ohio. Dept. of Metallurgy.

EFFECTS OF HYDROSTATIC PRESSURE ON THE MECHANICAL BEHAVIOR OF BODY CENTERED CUBIC REFRACTORY METALS AND ALLOYS Interim Technical Report

S. V. Radcliffe, G. Das, and P. Trester Dec. 1966 32 p refs
(Grant NsG-654)
(NASA-CR-82477) CFSTI: HC$3.00/MF$0.65 CSCL 11F

The magnitude and form of the decrease in yield stress in the model system Fe–Fe_3C was investigated as a function of applied pressure and the volume proportion and morphology of the second phase. The results show that the critical pressure for the onset of yield decrease depends on volume fraction, morphology and the purity of the matrix. A saturation pressure, beyond which

there is no further change, was indicated. Measurements of the microyield stress for specimens subjected to 20 kilobars indicate that the stress to move the pressure-induced dislocations is independent of the volume fraction of second phase within the range examined. In contrast, the microyield stress for specimens which were prestrained plastically in tension increased progressively with increasing volume fraction. A comparative transmission electron microscopy study of different types of tungsten demonstrated that the presence of doping additives in powder metallurgy tungsten can lead to the formation of small internal voids on annealing and recrystallisation. Author

N67-19042*# Syracuse Univ., N. Y.
APPLICATION OF RECENT STATIC ADHESION DATA TO THE ADHESION THEORY OF FRICTION
D. V. Keller, Jr. Aug. 1966 49 p refs Presented at the 13th Sagamore Conf. on Phys. and Chem. Characteristics of Surfaces and Interfaces, Aug. 1966 Submitted for Publication
(Grant NsG-483)
(NASA-CR-82371) CFSTI: HC $3.00/MF $0.65 CSCL 11F

The generally accepted theory of friction usually includes an adhesion parameter which in some schools has been contested and in others misinterpreted. The misunderstanding of the position of adhesion in friction relationships is usually based on the lack of knowledge of adhesion phenomena since reliable adhesion data are rather scarce and nearly as complex to interpret as the friction data to which they are applied. An examination of the variables influencing metallic friction as developed from recent vacuum friction experiments is reviewed briefly and compared to recent observations from static adhesion experiments between clean and specifically contaminated metal surfaces in order to establish a more sound basis for the adhesion theory of friction. Author

N67-19063*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
POSSIBLE RELATION OF FRICTION OF COPPER–ALUMINUM ALLOYS WITH DECREASING STACKING-FAULT ENERGY
Donald H. Buckley Washington, NASA, Mar. 1967 20 p refs
(NASA-TN-D-3864) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Friction experiments were conducted in a vacuum (10^{-11} torr) to determine the influence of stacking faults and stacking-fault energy on the shear and consequently the friction behavior of copper–aluminum alloys. The (111) plane of the single crystals slid parallel to the interface. The mating surface was polycrystalline aluminum oxide. Experiments were conducted at loads of 50 to 1000 grams and a sliding speed of 0.001 centimeter per second. The results of this investigation indicate that the friction coefficient for copper–aluminum alloys is related to the shear stress and stacking-fault energy for these alloys; the lower the stacking-fault energy, the higher the coefficient of friction. Author

N67-19066*# IIT Research Inst., Chicago, Ill.
METAL CARBIDE–GRAPHITE COMPOSITES Quarterly Report, 1 Nov. 1966–31 Jan. 1967
Y. Harada 31 Jan. 1967 35 p refs
(Contract NASr-85(09))
(NASA-CR-82527; IITRI-G6003-2; QR-2) CFSTI: HC $3.00/MF $0.65 CSCL 11D

Fabrication of metal carbide–graphite composites by hot pressing at temperatures up to 3200°C, and the determination of physical and mechanical properties of these materials are examined. The relationship between electrical conductivity and flexural strength is evaluated. Mixing laws for multiphase systems were employed to analyze electrical and mechanical properties. Heat treatment studies were conducted to examine annealing effects on physical and mechanical properties. Among the major conclusions were that high strengths are directly related to soaking of composites at processing temperature and also to the use of higher temperatures. A linear relationship appears between electrical conductivity and flexural strength for the NbC-C system in the compositional range, 20–88 volume per cent NbC. Heat treatment of high NbC content composites subsequent to hot pressing can result in significant improvement in strength due to sintering and diffusion bonding. The annealing process also produces dimensional changes due to relief of stresses which are imparted to billets on cooling after processing. S.P.

N67-19067*# National Bureau of Standards, Washington, D. C.
THE MECHANISMS OF STRESS CORROSION OF THE TITANIUM ALLOY Ti 8-1-1 EXPOSED TO SALT ENVIRONMENTS AT ELEVATED TEMPERATURES Final Report
Hugh L. Logan 4 May 1964 23 p ref
(NASA Order R-130; NBS Proj. 3120448)
(NASA-CR-82511; NBS-9468) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Stress corrosion cracking was produced in loaded bent beams of Ti 8-1-1 titanium alloy coated with NaCl and stressed to 80,000 and 40,000 psi. Several chlorides produced cracking of the bent beam specimens. A molten eutectic mixture of KCl and LiCl produced failures in U-bend specimens as soon as the specimen was wetted. Corrosion products found on surfaces of sheet specimens coated with NaCl contained anatase, rutile, and an unidentified phase. Sheet specimens stressed in a molten eutectic mixture of KCl and LiCl at 750°F failed after 50 minutes. Making the specimen the anode by applying a 3 volt potential had no effect on the exposure period to failure. Making the specimen the cathode with the same potential doubled the exposure period to failure. Cracking was produced in hollow specimens coated with $NaCl+MgCl_2 \cdot 6H_2O$ or coated with NaCl and in a moist argon atmosphere. Hollow specimens coated with NaCl and exposed to dry oxygen were crack resistant. Experiments to determine whether Cl_2, HCl, or NaOH were reaction products in the stress-corrosion cracking of the alloy were inconclusive. Stress-corrosion cracking was intercrystalline or followed the alpha–beta boundaries. R.N.A.

N67-19112*# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
THE EFFECT OF FIBRE ORIENTATION ON THE TENSILE STRENGTH OF HOT-PRESSED ALUMINUM–INCONEL AND ALUMINUM–TUNGSTEN COMPOSITES
B. G. Childs Sep. 1966 38 p refs
(AECL-2605) CFSTI: HC $3.00/MF $0.65

Model composites of Inconel or tungsten fibres in a matrix of 56 S aluminum alloy have been produced by pressing wire bundles of 0.004 in. diameter wires at 500°C. The tensile strength at 20°C of the composites, and also of the unreinforced matrix, was measured as a function of the wire orientation relative to the stress direction. The strength was found to decrease much more rapidly with orientation than would be expected if it were determined, above a certain critical angle, by the flow stress of the matrix. This behavior apparently results from the presence of oxide interfaces in the specimens which are relatively weak in tension and shear. Values were obtained for the tensile and shear strengths of these interfaces in the specimens studied. Author

N67-19118*# Aluminum Co. of America, New Kensington, Pa. Alcoa Research Labs.
DEVELOPMENT OF IMPROVED CONVERSION COATINGS FOR ALUMINUM ALLOYS Final Report, 1 May 1964–31 Jul. 1966

W. G. Zelley 14 Sep. 1966 248 p
(Contract NAS8-11226)
(NASA-CR-82660) CFSTI: HC $3.00/MF $0.65 CSCL 11F

An investigation was conducted on the protection of 2219 alloy by chemical conversion coating techniques, with reference to space vehicle components. The corrosion properties of the alloy in various tempers were considered, and the Iridite 14-2 process, now in use, was studied. Other conversion coatings, with and without chromate, were considered. Surface preparatory treatments were investigated, and the advantage of a mechanical finish for producing an effective coating was shown. Electrochemical assists, double coating, and sealing were evaluated. The value of reducing Iridite solution pH or increasing the concentration was demonstrated, and a 10 oz/gal. solution was studied in depth. Production operational problems were considered, including a pilot plant scale test. Salt spray, humidity, and atmospheric exposure tests were conducted on 2219 alloy in various tempers and on other representative aluminum alloys. The exposure and alloy factors affecting results are discussed. Although the objective of a completely protective coating on 2219-T87 alloy in a 168 hours salt spray exposure was not attained, recommendations were made for the optimum processing of this material according to the data accumulated. Author

N67-19132*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
STUDY OF THE GROWTH PARAMETERS INVOLVED IN SYNTHESIZING BORON CARBIDE FILAMENTS Final Report
A. Gatti, E. Feingold, J. J. Gebhardt, J. M. Berry, and V. A. Cordua Nov. 1966 52 p refs /ts Rept.-214-186
(Contract NASw-1383)
(NASA-CR-82447) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Whiskers of B_4C were grown in a chimney-type graphite resistance furnace. However, the geometry of the whisker growth zone in this furnace resulted in curved whiskers instead of the more desirable straight variety. Thus, studies of the growth and deposition-zone geometry on whisker production were conducted. A new furnace geometry resulted from these studies, and has resulted in producing a much larger number of whiskers per run. Other studies were directed towards producing B_4C whiskers by a chemical vapor deposition method which would be more amenable to economic scale-up of the growth process. Kinetic and thermodynamic calculations were re-examined and B_4C whiskers have been grown utilizing boron tribromide and carbon tetrachloride at temperatures near 1400°C. Heat treatment of the curved whiskers was investigated. All whiskers annealed at 1600°C and above became straighter but did not retain their as-grown strength. Author

N67-19133*# National Research Corp., Cambridge, Mass. Norton Exploratory Research Div.
MECHANISM OF THE ATMOSPHERIC INTERACTION WITH THE FATIGUE OF METALS Summary Report, 4 Aug. 1965–1 Sep. 1966
M. J. Hordon, M. A. Wright, and M. E. Reed 1 Sep. 1966 55 p refs
(Contract NASw-1231; NRC Proj. 5118-1-01231)
(NASA-CR-82448) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Measurements of the fatigue properties of 1100-H14 aluminum in vacuum were extended to include variations in temperature, residual gas composition and reduced pressure level. Fatigue tests both in air or vacuum interrupted after nucleation of a visible crack and continued at a different pressure level demonstrated that the crack initiation phase of the fatigue process was insensitive to the ambient gas pressure. The transitional pressure level was observed to increase with both temperature and cyclic stress frequency. Tests carried out in a pure H_2 gas atmosphere showed that the transition pressure level for fatigue life improvement could be raised to pressures approaching unit atmosphere. At 5×10^{-11} Torr, a two-fold increase in cyclic stress frequency resulted in a proportional increase in the number of cycles required for failure. It was concluded that the total exposure time to the residual oxygen environment was the controlling parameter for the fatigue process at this vacuum level rather than the number of alternating stress applications. Author

N67-19192# Soudometal, S. A., Brussels (Belgium).
WELDING OF STEEL IN HIGH-THICKNESS [SOUDAGE DES ACIERS DE FORTES EPAISSEURS] Final Report
W. Soete, R. Dechaene (Gand Univ.), R. Daemen, H. Desguin, G. Doneux et al EURATOM, Nov. 1966 88 p refs In FRENCH; ENGLISH summary
(Contract EURATOM-042-61-9 RDB)
(EUR-2690.f; EURAEC-1548) CFSTI: HC $3.00/MF $0.65

As part of a study of the means by which a brittle fracture may be initiated in very thick steel vessels for nuclear reactors, an attempt was made to determine the main parameters of this phenomenon, for example the composition of the filler metals, the welding conditions, the operating methods, the thermal conditions, heat treatments (in particular stress-relief) and the temperature safety-margins to be envisaged for the construction of welded assemblies. Author

N67-19268# Deutsche Forschungsanstalt für Luft- und Raumfahrt, Brunswick (West Germany). Institut fuer Flugzeugbau.
APPLICATION OF THE PROT ACCELERATED METHOD FOR THE DETERMINATION OF THE FATIGUE STRENGTH OF OVERLAPPED METAL BONDED JOINTS [DIE ANWENDUNG DES PROT-ABKUERZUNGSVERFAHRENS ZUM BESTIMMEN DER DAUERSCHWINGFESTIGKEIT VON UEBERLAPPTEN METALLKLEBVERBINDUNGEN]
W. Althof 25 Aug. 1966 28 p refs In GERMAN; ENGLISH summary
(DLR-FB-66-67) CFSTI: HC $3.00/MF $0.65

The fatigue strength of overlapped metal bonded joints of steel and light metal was determined by the Wöhler experiment and the accelerated Prot method. After a comparision of the test results, a variation of the Prot method is demonstrated, by which the fatigue strength values determined according to Wöhler and Prot may be accommodated. Author

N67-19269# United Kingdom Atomic Energy Authority, Springfields (England). Reactor Fuel Element Lab.
HETEROGENEITY IN THE DISLOCATION ASSEMBLY: ITS EFFECT UPON THE PROBABILITY OF FATIGUE FAILURE
J. H. Gittus 1966 14 p refs
(TRG-1294(S)) CFSTI: HC $3.00/MF $0.65

Discussed is a statistical model for a metallic alloy exhibiting heterogeneity that considers the side potential as well as the kinetic energy for the dislocation assembly. The site potential is variable and coupled to the vibrational energy. Statistical dynamics are employed to find expressions for the mean dislocation velocity of line and point defects in terms of stress, temperature, and frequency of atomic vibration; a diffusion equation describes the dislocation motions and relates the mobile dislocation densities with strain time values. The behavior near the crack tip is in this way related with the macroscopic conditions applied to the body directional or by cyclically reversed stress system as a whole and this leads to a fatigue law for failure by crack propagation. Experimental data on fatigue and creep properties of 20Cr-25Ni-Nb stainless steel and aluminum-magnesium provide fatigue failure probability predictions of reasonable values. It is concluded that the probability of fatigue failure can be deduced from the dynamics of a heterogeneous dislocation assembly. G.G

18 MATERIALS, NONMETALLIC

Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics.

N67-18258# Army Natick Labs., Mass. Pioneering Research Div.

THERMAL CONDUCTIVITY OF SOFT VULCANIZED NATURAL RUBBER: SELECTED VALUES

Louis C. K. Carwile and Harold J. Hoge Jun. 1966 34 p refs (TR-66-49-PR; AD-643325) CFSTI: HC $3.00/MF $0.65

The published literature on the thermal conductivity of natural rubber was assembled and the results critically evaluated. Best values of thermal conductivity as a function of temperature were selected. These are presented in both graphical and tabular form; the tables cover the range 80 to 380K. An attempt was made to consult all work that could significantly affect the choice of best values. Published papers were located with the aid of Chemical Abstracts, Physics Abstracts, the Thermophysical Properties Retrieval Guide, and some other general sources. In addition, relevant references in the papers themselves were followed up until a substantially closed system had been generated, as shown by the fact that no new references were being turned up. Author (TAB)

N67-18436# Picatinny Arsenal, Dover, N. J. Plastics Technical Evaluation Center.

PLASTICS IN GOVERNMENT

Harry E. Pebly, Jr. Jul. 1966 55 p refs Presented at the 1966 Ann. Conf. on Soc. of the Plastics Ind., New York City, 7–9 Jun. 1966

(PLASTEC-13; AD-642299) CFSTI: HC $3.00/MF $0.65

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4. NEEDS FOR CHARACTERIZATION AND PROCESS CONTROL OF LOW-DENSITY COMPOSITES FOR AEROSPACE APPLICATION J. A. Parker (NASA, Ames Res. Center) p 31–46 (See N67-18440 08-18)

N67-18437# Picatinny Arsenal, Dover, N. J. Plastics and Packaging Lab.

PLASTICS IN AMMUNITION

Jacob D. Matlack *In its* Plastics in Govt. Jul. 1966 p 1–7 (See N67-18436 08-18) CFSTI: $3.00/MF $0.65

Presented is a discussion of plastics being utilized in the ammunition field, and the reasoning behind specification requirements for plastic items. Described are items made from glass fiber reinforced polystyrene such as the M18A1 anti-personnel mine which is used above the surface of the ground for perimeter defense or as a booby trap device; and the grommet for protecting the rotating band on separate loaded projectiles. Also discussed is the use of plastics as containers for a projected line charge, complete rounds of ammunition, and containers for the round of the 81mm mortar. An example of the use of polystyrene foam as the package for standard contour fuses is also cited. The development of specification requirements for the 81mm container is discussed to illustrate the reasoning behind specification requirements for plastic items. S.C.W.

N67-18438# Naval Ship Engineering Center, Washington, D. C.

PLASTICS DEVELOPMENTS IN SHIPS

John B. Alfers *In* Picatinny Arsenal Plastics in Govt. Jul. 1966 p 8–11 (See N67-18436 08-18) CFSTI: HC $3.00/MF $0.65

A discussion of the future potential use of reinforced plastics and plastic foams in Naval ships and ship associated activities is presented. Cited is the use of plastics as boat building materials, masts, topside structures for surface ships, buoyancy materials for deep diving vehicles, and foams for salving sunken vessels. S.C.W.

N67-18439# Air Force Systems Command, Wright-Patterson AFB, Ohio.

APPLICATIONS OF PLASTICS FOR AEROSPACE USE

William Postelnek *In* Picatinny Arsenal Plastics in Govt. Jul. 1966 p 12–30 (See N67-18436 08-18) CFSTI: HC $3.00/MF $0.65

Presented is a discussion of current Air Force advanced applications of plastic materials. Emphasized are requirements for advanced applications, new materials technology, advanced applications prototypes, and inherent problems limiting the widespread use of plastic composites as primary materials for aerospace structures. The need for a transparent material for aircraft glazing; better plastic materials for composites for reentry vehicles and rocket nozzle applications; a plastic material for aircraft radome applications; and plastic materials for rotating parts engine compressor applications; is considered. New materials under consideration as resins and filaments which are under evaluation for composites are described. Among the prototypes described are cited an epoxy-glass aircraft landing gear prototype; three prototype structures made from gelatin impregnated fluted core glass fabric which offer promise as expandable structures for space and extraterrestrial applications; a prototype light weight, metal lined, filament wound tankage, capable of long time storage of propellants and oxidizers such as N_2O_4, LOX, and hydrazine; and a prototype subscale radome made from PBI S-glass laminate, which was designed to meet the requirement for operation of 600°F. Inherent problems which limit the use of plastics as composite materials for aerospace structures such as the paucity of reliable design data, and the need for the standardization of existing test methods and the development of new techniques; are cited. S.C.W.

N67-18440# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

NEEDS FOR CHARACTERIZATION AND PROCESS CONTROL OF LOW-DENSITY COMPOSITES FOR AEROSPACE APPLICATION

John A. Parker *In* Picatinny Arsenal Plastics in Govt. Jul. 1966 p 31–46 refs (See N67-18436 08-18) CFSTI: HC $3.00/MF $0.65

A critical examination of off-the-shelf plastic components used in the formulation of low density composites revealed that they can introduce defects in the microstructures of low density composites which are potential sites for mechanical failure in aerospace applications. Upgrading components to achieve uniformity and reproducibility and modifying the conventional processing to eliminate defects have shown that substantial improvements in the physical properties can be made in conventional low density composites, as well as in obtaining a degree of characterization not

heretofore available. It has been shown that the composition, density, and mechanical strength and interconnected porosities of low density composites can be controlled by applying analytical techniques to the formulation of low density composites. Results suggest that these methods may find application in the commerical world to improve properties of low density composites. Although the study has emphasized low density composites of potential use as reentry heat shields, similar considerations apply to other applications of plastics. The study presented suggests a real need for obtaining a more thorough characterization of plastic products than has been necessary in the past. Processing techniques which have given acceptable products must be re-examined in terms of these new needs to obtain the degree of reliability required, and to secure specific property improvements. Author

N67-18617*# IIT Research Inst., Chicago, Ill. Technology Center.
DEVELOPMENT OF SPACE-STABLE THERMAL-CONTROL COATINGS
G. A. Zerlaut and F. O. Rogers 30 Nov. 1966 89 p refs
(Contract NAS8-5379)
(NASA-CR-82091; IITRI-U8002-47) CFSTI: HC $3.00/MF $0.65 CSCL 11C

The work reported consists of (1) space simulation tests on inorganic powders and coatings employing both post-exposure and in situ reflectance measurements, (2) synthesis of zinc titanate pigment, (3) evaluation of the optical and stability characteristics of zinc titanate and zinc titanate-pigmented coatings, (4) solvent studies pertaining to various silicone paints, (5) methyl silicone photolysis studies, and (6) checkout and calibration tests on the new in situ reflectometer/irradiation facility. Author

N67-18678 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
IMPROVEMENT OF ORGANIC RESINS AND STUDY OF THEIR THERMAL BEHAVIOR [AMELIORATION DES RESINES ORGANIQUES ET ETUDE DE LEUR COMPORTEMENT THERMIQUE]
S. Kohn *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 31
(See N67-18661 08-34) CFSTI: $3.00

A summary outline of the synthesis of organo-mineral, and improved phenol resins is presented. Emphasis is placed on thermostable resins for light, and mechanically resistant structures, and the synthesis of resins for use as heat shields. The application to aircraft ablating material is noted. Transl. by R.Li.

N67-18876# Union Carbide Nuclear Co., Oak Ridge, Tenn.
CURING PLASTICS WITH GAMMA RADIATION
W. L. Harper and B. Napier, Jr. 17 Oct. 1966 25 p refs
(Contract W-7405-ENG-26)
(Y-1562) CFSTI: HC $3.00/MF $0.65

Several monomeric systems were polymerized with gamma radiation. Shear and compressive strengths were determined and correlated with the radiation dose. Author (NSA)

N67-18977*# West Virginia Univ., Morgantown. Engineering Experiment Station.
DEVELOPMENT OF CONSTITUTIVE EQUATIONS FOR NUCLEAR GRADE GRAPHITE FOR SPACE APPLICATIONS I Final Report
R. D. Snyder Dec. 1966 119 p
(Grant NsG-533)
(NASA-CR-82398; NASA-6-65) CFSTI: HC $3.00/MF $0.65 CSCL 11B

The object of this work was to determine and measure the significant parameters of the room temperature mechanical behavior of various chemical and experimental graphites. A series of 189 uniaxial compression two-cycle uniform load-rate tests was conducted. Using resistance type strain gauges, continuous axial and Poisson strain versus load curves were recorded. From these curves were obtained values for the ultimate nominal stress, ultimate strains, second-cycle elastic modulus, Poisson ratio, and the strain damage at 80% nominal ultimate stress. The data were tabulated in a manner to reflect their dependence on orientation, location, and graphite sub-type. Finally, since the recorded data were continuous two-cycle load versus strain curves, a computerized procedure was developed for converting this load–strain flexure data to stress–strain data. These stress–strain data were then compared with the nominal stress–strain data. Author

N67-19010# Los Alamos Scientific Lab., N. Mex.
CARBIDE–GRAPHITE COMPOSITES
K. V. Davidson, R. E. Riley, and J. M. Taub 19 Oct. 1966 61 p refs
(Contract W-7405-ENG-36)
(LA-3569-MS) CFSTI: HC $3.00/MF $0.65

The effects of process variables on the high temperature properties of hot pressed carbide–graphite composites is not well understood. A program to evaluate these effects by holding certain variables constant is described. The results of the effects of these variables are reported and include powder characterization, hot pressing conditions, composition, carbide versus metal powder additions, binder content, graphite particle size and type, and correlation of microstructures with resistance to deformation at elevated temperatures. Author (NSA)

N67-19070 Gt. Brit. Ministry of Aviation, London.
EFFECT OF METALLIC OXIDES ON THE SINTERING OF ALUMINA
Kato Shuzo, Iga Takeo, Sano Shiro, and Eiichi Ishii Nov. 1966 10 p refs Transl. into ENGLISH from Nagoya Kogyo Gijutsu Shikensho Hokoku (Japan), v. 14, no. 3, 1965 p 104–109
(TIL/T-5639) CFSTI: $3.00

Rates and activation energies were measured for sintering alumina containing 2 or 5 wt% of MgO, Cr_2O_3, TiO_2 and MnO_2 over the temperature range 1400 to 1650°C. The approximate sintering relationship is $P = Kt^n$ (P is extent of sintering, n an exponent from temperature and specimens, K a constant). The effects of the various additives are compared and self-diffusion coefficients calculated from Kingery's equation. Author

N67-19101*# Borden Chemical Co., Philadelphia, Pa. Central Research Lab.
DEVELOPMENT OF IMPROVED ADHESIVES FOR USE AT CRYOGENIC TEMPERATURES TO −423°F Final Summary Report, 11 Jul. 1963–31 Aug. 1965
Stanley R. Sandler, Florence Berg, and George Kitazawa 15 Sep. 1966 79 p refs
(Contract NAS8-11518)
(NASA-CR-82602) CFSTI: HC $3.00/MF $0.65 CSCL 11J

Polyurethanes and epoxy resins were evaluated as cryogenic adhesives showing good tensile shear and T-peel properties over the temperature range of −423°F to 400°F. Several other chemical structures were also investigated. Polyethers were found to give the highest tensile shear strength and T-peel on aluminum but had poor properties at 250°F and 400°F. Modification of the polyol, diisocyanate, or amine curing did not alleviate the problem. Copolymerizing epoxy resins with good high temperature tensile shear properties with polyurethanes which lacked these properties

gave only a small increase over the latters' results for the homopolymer. The discovery of a new polymer system is reported. Studies of several bisphenol epoxy adhesives indicated that the substituents in the aromatic ring had no effect on adhesive performance but that the epoxy content was the major factor. The use of epoxy esters (polyglycidyl esters of polycarboxylic acid) yielded some adhesives that showed much higher tensile shear strengths than bisphenol A epoxies at 400°F when cured with 4,4'-diaminodiphenylmethane at 100°C. Attempts to improve the T-peel strength of the epoxy resins by the addition of some polyether structures led to a decrease in the elevated temperature properties. It is concluded that several adhesives have been made which meet all the temperature requirements but do not have the proper T-peel strength when cured at 73°F. S.C.W.

N67-19125*# IIT Research Inst., Chicago, Ill.
DEVELOPMENT OF LIGHTWEIGHT THERMAL INSULATION MATERIALS FOR RIGID HEAT SHIELDS Final Summary Report, 25 Jun. 1964–25 Sep. 1966
A. J. Mountvale and H. H. Nakamura Oct. 1966 58 p
(Contract NAS8-11333)
(NASA-CR-82454; IITRI-G-6002-27) CFSTI: HC $3.00/MF $0.65 CSCL 11B

A program of engineering and scientific research has been carried out to develop lightweight ceramic foams which will provide adequate insulation and survive the mechanical environment associated with launch operations. Castable ceramic foams of zircon, mullite, and calcium aluminate have been prepared and evaluated for use as rigid heat shields in launch vehicles. Chemically bonded, castable type zircon foams of 1/2 in. thickness show good insulative and mechanical characteristics when subjected to a heat flux of 40 Btu/ft^2-sec with simultaneous vibration of 60 cps, 1/2 in. double amplitude displacement and 90 g's acceleration, as well as to a specific sinusoidal sweep–random vibrational test up to 2000 cps. Property measurements on an optimized zircon foam disclosed very high optical reflectance in the near-infrared wavelength region and an extremely low thermal conductivity of 2300°F. Author

N67-19144# Sandia Corp., Albuquerque, N. Mex.
DECOMPOSITION KINETICS OF THE PHENOLIC-CARBON CLOTH FM 5055A ABLATOR. I. RATE-CONTROLLING REACTION: COMPLEX SECOND ORDER
Irving Auerbach Nov. 1966 30 p refs
(Contract AT(29-1)-584)
(SC-RR-66-584) CFSTI: HC $3.00/MF $0.65

An isothermal kinetic study was conducted on the decomposition of the phenolic-carbon cloth FM 5055A ablator over the temperature range from 104 to 718°C and at pressures of 0.1 to 0.2 torr. The results were fitted to a modified second-order kinetic expression describing the decomposition. A plot of the equilibrium constant versus temperature provided the enthalpy change for two temperature ranges. These values were correlated with specific reactions in the decomposing resin. An Arrhenium plot for the rate constants and temperature showed that four distinct temperature ranges exist in which the rate constants, and the effect of temperature on the rate constants, differ. NSA

N67-19160 Rubber Research Inst. TNO, Delft (Netherlands).
RAISING THE INSPECTION STANDARDS FOR BUTYL-RUBBER INSULATION IN NEOPRENE SLEEVES OF MARINE CABLES [ONDERZOEK NAAR DE MOGELIJKHEID EEN VERHOGING VAN DE KEURINGSEISEN VOOR BUTYL-RUBBER ISOLATIE EN NEOPREENMANTEL VAN MARINEKABELS TE REALISEREN]
G. A. Gerritse and W. J. v. d. Veen Oct. 1966 12 p
(TDCK-46586) CFSTI: HC $3.00

Cable mixtures with butyl rubber and neoprene bases were examined and compared with insulation and sleeve mixtures currently in use. Physical and mechanical properties of the mixtures were evaluated following vulcanization between 120° and 160°C; vulcanization times were varied. The results are presented in tables. Test results indicate that improvements can be realized in the area of neoprene mixtures for cable sleeves. No significant improvements were noted in the insulation characteristics of the butyl rubber mixtures that were tested. Transl. by K.W.

19 MATHEMATICS

Includes calculation methods and theory; and numerical analysis. For applications see: 08 Computers.

N67-18233 Max-Planck-Institut fuer Stromungsforschung, Göttingen (West Germany).
ON THE NUMERICAL APPLICABILITY OF THE PARAMETRIX METHOD BY PARTIAL DIFFERENTIAL EQUATIONS [UEBER DIE NUMERISCHE ANWENDBARKEIT DER PARAMETRIXMETHODE BEI PARTIELLEN DIFFERENTIALGLEICHUNGEN]
D. Grohne 1965 47 p refs In GERMAN
(Rept.-33) CFSTI: HC $3.00

The parametrix method has been proposed for solving linear boundary value problems of second order elliptical differential equations. The parametrix, which is a generalized Green function, changes the equation into a differential equation of the second type; the boundary conditions are thereby automatically fulfilled. The generalized applicability to differential equations of higher order and to boundary value problems of the parabolic type is demonstrated, and numerical calculations are performed. Transl. by K.W.

N67-18271# United Kingdom Atomic Energy Authority, Harwell (England). Information Branch.
QUADRATURE FORMULAE
S. M. Nikol'skii Jun. 1966 147 p refs Transl. into ENGLISH from Russian
(AERE-TRANS-1055) HMSO: 18s

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N67-18272# United Kingdom Atomic Energy Authority, Harwell (England). Research Group.
QUADRATURE FORMULAE WITH LEAST ERROR ESTIMATE FOR SOME CLASSES OF FUNCTIONS
J. A. Shaidaeva *In its* Quadrature Formulae Jun. 1966 p 104-139 refs Transl. into ENGLISH from Tr. Mat. Inst., Akad. Nauk SSR (Moscow), v. 53, 1959 p 313–341 (See N67-18272 08-19) HMSO: 18s

The problem of minimizing the quadrature residue is discussed for 1) the class of functions which satisfy the condition $|f^{r}(x)| \leq M_2$ ($r=2$), for which the second derivative is bounded in absolute magnitude; 2) the class of functions having an rth derivative whose qth power is integrable ($q>1$) and satisfying the condition $\left|\int |f^{(r)}(x)|^q dx\right|^{1/q} \leq M_r$; and 3) the class of functions whose derivative of order $r-1$ has bounded variation and satisfies the condition var $f^{(r-1)}(x) \leq M_r$. L.S.

N67-18277 Union Carbide Nuclear Co., Oak Ridge, Tenn. Y-12 Plant.
CUBIC SPLINE: A CURVE FITTING ROUTINE
A. H. Fowler and C. W. Wilson 28 Jun. 1966 74 p refs Revised
(Contract W-7405-ENG-26)
(Y-1400, Rev. 1) CFSTI: HC $3.00/MF $0.65

A method of mathematically fitting a curve through a given ordered set of points was developed and programmed in FORTRAN computer language. The fitted curve, which is made up of a series of normalized cubic polynomials, very nearly approximates the curve generated by passing an infinitely thin spline through the sets of points and is, therefore, called a "cubic spline." The curve has the properties of continuous position, slope, and curvature. The restraints placed upon the cubic spline may be relaxed by applying an additional feature which permits the points to be adjusted by, at most, some preset value. This has the effect of smoothing the curve in the sense that it reduces the strain energy stored in it while preserving the general shape of the curve. Tool centers for numerically controlled tools may be found with the interpolation and offsetting methods included. Author (NSA)

N67-18302*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
DEPENDENCY OF CONSTRAINTS FOR DIFFERENTIAL EQUATIONS
A. J. Semtner *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 1–2 ref (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

Proposed is a method for answering the question of whether there exists a solution to a system of ordinary differential equations

$$\dot{x}_1 = X_1(x_1, \ldots x_n)$$
$$\bullet \qquad \bullet$$
$$\bullet \qquad \bullet$$
$$\bullet \qquad \bullet$$
$$\dot{x}_n = X_n(x_1, \ldots x_n)$$

which also satifies a number of constraints

$$\Xi\ (x_1, \ldots x_n) = 0$$
$$\bullet \qquad \bullet$$
$$\bullet \qquad \bullet$$
$$\bullet \qquad \bullet$$
$$\Xi\ (x_1, \ldots x_n) = 0$$

It is shown that by means of a transformation algorith, the differential equations are transformed successively until a stop condition is satisfied. A necessary and sufficient condition that a solution exist which is compatible with the constraints is that certain functions which arise in the transformation procedure have the value zero when all of their arguments are zero. A minor variation in the problem arises when the Ξ are allowed to be functions not only of the x's, but also of certain parameters $a_1, \ldots a_m$. The question is then asked how the constraints must be related (in terms of conditions on the a's) in order for a compatible solution to exist. An application of the transformation procedure supplies the answer that such a solution exists if and only if certain functions of the a's are zero. S.C.W.

N67-18306*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ON GEOMETRIC PROPERATIES OF THE ESTABROK-WAHLQUIST FUNCTION CHAIN
E. M. Keberle *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 15–18 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

A quasilinear non-elliptic partial differential equation of higher order for the principal part of the Estabrook-Wahlquist function chain is analyzed. Also discussed is the formulation of a condition for a solution of the system of ordinary differential equations,

$$\dot{x}_1 = X_1(x_1, \ldots x_n)$$
$$\bullet \qquad \bullet$$
$$\bullet \qquad \bullet$$
$$\bullet \qquad \bullet$$
$$\dot{x}_n = X_n(x_1, \ldots x_n)$$

to be compatible with the equation

$$x_1(t), \ldots x_n(t) = 0$$

for all t. S.C.W.

N67-18307*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RELATIONSHIP BETWEEN THE AVERAGING METHOD OF KRYLOV-BOGOLIUBOV AND AN APPROXIMATE FIRST INTEGRAL OF MOTION
H. Lass *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 19–22 ref (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

Described is a technique for establishing the relationship between the averaging method of Krylov-Bogoliubov and an approximate first integral of motion. Solutions obtained from the method correspond to the Bogoliubov-Mitropolsky first approximate solution. S.C.W.

N67-18357*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
CONCERNING THE PROPER ROTATIONS OF A 3-DIMENSIONAL ORTHOGONAL FRAME
Albert G. Gluckman Washington, NASA, Feb. 1967 15 p refs
(NASA-TN-D-3808) CFSTI: HC $3.00/MF $0.65 CSCL 12A

This mathematical discussion concerning the proper rotations of a 3-dimensional orthogonal frame is a study of the 6 different elements of the group of proper rotations, the proper orthogonal

group $O^+(3)$ (or as it is otherwise called, the special orthogonal group SO(3)), which are formed as products of the 3 elements M_x, M_y, and M_z, expressing rotation about each of the 3 coordinate axes. These 31 products are formed by permutating the order of the multiplication of the 3 proper rotation matrices, M_x, M_y and M_z where they describe rotation of the frame about the x-, y-, and z-coordinate axis. The angles of rotation are chosen in such a manner, that no one of the unimodular factors M_x, M_y, and/or M_z is an identity element: thus $\theta_i \neq \pm 2k\pi$; i=1, 2, or 3; k=0 or a positive integer. For in that eventuality, the system which is described would be reduced to one involving 2 proper rotation matrices only. Such a case would then be a constraint placed upon the system as originally conceived, which would affect the generality of the conclusions. The angles θ_1, θ_2, and θ_3 of rotation about the x-, y-, and z-coordinate axis respectively, are elements of the field R_1 of real numbers. The frame itself is embedded in a 3-dimensional continuum, which though it could be globally Euclidean, is at the least locally Euclidean. Author

N67-18361# Royal Aircraft Establishment, Farnborough (England).
A MATRIX METHOD FOR THE DERIVATION OF TRANSFER FUNCTIONS IN TERMS OF PARTIAL FRACTIONS
J. M. Freeland Sep. 1966 18 p refs
(RAE-TR-66294) CFSTI: HC $3.00/MF $0.65

Matrix methods are used to obtain transfer functions of linear control systems directly in terms of partial fractions. Two examples are given, one containing simple roots and the other containing multiple roots. Author (ESRO)

N67-18362# National Aero- and Astronautical Research Inst., Amsterdam (Netherlands).
NOTES ON THE USE OF FINITE DIFFERENCE METHODS IN THE COMPUTATION OF INCOMPRESSIBLE POTENTIAL FLOWS
G. Y. Nieuwland 28 May 1965 27 p refs
(NLR-TN-T-137) CFSTI: HC $3.00/MF $0.65

A procedure for the numerical solution of problems of steady incompressible potential flow around in general three dimensional bodies is proposed. Variational techniques are combined with finite difference methods. Error bounds are given for the error involved in truncating the domain of definition of the solution to a bounded region and for the discretization error; the two estimates can be compared. The use of incidence matrices to permit automatic generation of the systems of linear equations defining the numerical solution for irregularly spaced grid points is discussed. Author (ESRO)

N67-18410*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
CHARACTERIZATIONS OF REAL LINEAR ALGEBRAS
Anthony P. Cotroneo Washington, NASA, Feb. 1967 60 p refs
(NASA-TN-D-3863) CFSTI: HC $3.00/MF $0.65 CSCL 12A

Some characterizations and properties of linear algebras (or hypercomplex systems) over the field of real numbers are presented with essential definitions and theorems concerning real linear algebras on which neither the commutative property nor the associative property of multiplication is defined. Theorems relating the concepts of normed, absolute valued, and division algebras are also given. In addition, algebras which are commutative or associative with respect to multiplication are considered. A construction of the algebra of real quaternions is given with a proof of the classical result of Frobenius which illustrates the unique place of complex numbers and quaternions among the algebras. Except for isomorphisms, the real numbers, the complex numbers, and the algebra of real quaternions form the only associative division algebras over the field of real numbers. The algebra of real quaternions is discussed in detail. It is shown that all automorphisms on this algebra form a group of linear orthogonal transformations which in turn define the group of all rotations on the real Euclidean vector space of dimension three. The illustrations presented point out many ways in which quaternions can be handled. Author

N67-18415# Georgia Inst. of Tech., Atlanta. School of Electrical Engineering.
THE GENERATION OF A GAUSSIAN RANDOM PROCESS IN A POSITION PARAMETER
David L. Finn and W. A. Yates 14 Dec. 1965 33 p refs
(Contract NAS8-2473)
(NASA-CR-62016; GIT/EES-A588/T10; TN-10) CFSTI: HC $3.00/MF $0.65 CSCL 09D

A method is presented for approximating, by use of analog computer components, any prescribed stationary Gaussian random process depending only on a position parameter x. The output of the analog mechanization system simulates the effect of the prescribed random process on some physical device or sensing element whose variable location is specified by the position parameter x. The two inputs to the mechanization system are Gaussian white noise and the first derivative of the function of time describing the position of the sensing element. Best approximation of the prescribed random process is obtained when the second derivative of the function of time describing the position of the sensing element is restricted to small values. Author

N67-18452# Syracuse Univ. Research Inst., N. Y.
APPROXIMATE SOLUTIONS OF NON-LINEAR FUNCTIONAL EQUATIONS, PART 6
L. F. Chang *In its* Theory of Adaptive Mech. Nov. 1966 p 112–123 refs (See N67-18447 08-08) CFSTI: HC $3.00/MF $0.65

This report is intended to be a preliminary investigation on the feasibility of carrying out various methods of finding the approximate solution to a non-linear functional equation, especially in the form of Fredholm integral equation, by CDC-160-RADCIAC-system. Various schemes of finding the approximate solution are surveyed from the view point of functional analysis. The general procedure is to reduce the non-linear functional equation to a set of non-linear algebraic equations which, it is hoped, approximate the original equation in some sense. These simultaneous algebraic equations then can be solved approximately by simple iterative procedure or by Newton's method. Author

N67-18465# International Centre for Theoretical Physics, Trieste (Italy).
ON REPRESENTATIONS OF LIE ALGEBRAS WITH UNBOUNDED GENERATORS. I: PHYSICAL CONSEQUENCES AND MATHEMATICAL PROPERTIES OF DOMAINS
H. D. Doebner and O. Melsheimer 1966 37 p refs Sponsored in part by Boundesmin. fuer Wiss. Forschung
(ICC-66/97)

In skew-adjoint representations of non-compact Lie algebras unbounded generators necessarily occur. The physical relevance of the domain $\mathcal{D}$ on which the unbounded generators are defined, is discussed by mathematical techniques due to Nelson. It is explicitly shown that the physical content of a representation depends on the domain $\mathcal{D}$. Some mathematical properties of such domains, which are related to group representations, are collected and formulated. Problems of non-relativistic quantum mechanics (integrable and non-integrable ray representations of the Galilei group, uncertainty relations) and questions related to a nontrivial combination of space–time and internal symmetries (partially integrable representations) are treated as examples. Domains from ladder representation are derived and an integrability proof for these representations is given. Author (NSA)

N67-18469# Stanford Univ., Calif. Dept. of Statistics.
CHANCE-CONSTRAINED PROGRAMMING WITH 0-1 OR BOUNDED DECISION VARIABLES
Frederick S. Hillier 26 Aug. 1966 46 p refs Supported in part by NASA
(Contracts Nonr-225(53); Nonr-225(89))
(NASA-CR-81875; TR-92; AD-639810) CFSTI: HC $3.00/MF $0.65 CSCL 12A

The paper considers the chance-contrained programming problem where the decision variables can be either bounded and continuous or restricted to be either zero or one, and where some or all of the elements of A, B, and C are random variables that may be statistically dependent. Both exact and approximate solution procedures are presented, where most of these are based on several linear inequalities that permit this problem to be approximated by a number of ordinary (integer or noninteger) linear programming problems. Either zero-order or linear decision rules are allowed for the continuous variables, and a general method of making 'second-stage decisions' with either continuous or 0-1 variables is developed. Author (TAB)

N67-18541*# Emory Univ., Atlanta, Ga.
MATHEMATICS-SCIENCE-EXPERIENCE
Tomlinson Fort [1966] 15 p refs
(Grant NsG-545)
(NASA-CR-82008) CFSTI: HC $3.00/MF $0.65 CSCL 12A

A general discussion is presented on mathematics, its definitions, and its relation to the sciences. Several definitions are quoted, and a brief description of mathematical isomorphism is given. Both the formalist and the intuitionist point of view are included. N.E.N.

N67-18705*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
A VECTOR APPROACH TO THE ALGEBRA OF ROTATIONS WITH APPLICATIONS
Paul B. Davenport Nov. 1965 36 p refs Submitted for Publication
(NASA-TM-X-57187; X-546-65-437) CFSTI: HC $3.00/MF $0.65 CSCL 12A

Vector multiplication is used to define a group whose elements are vectors and which is isomorphic to the group of rotations. The vector representation of rotations, which has many advantages over the usual matrix or Eulerian angles approach, avoids the need for trigonometric relationships and requires only three independent parameters. The simplicity of this vector representation is demonstrated by its use in several applications; an analytic solution to a least-squares rotation problem is presented, and the differential equations defining the motion of a rigid body are obtained in terms of a vector differential equation. Author

N67-18743*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
NUMERICAL TECHNIQUES FOR THE SOLUTION OF SYMMETRIC POSITIVE LINEAR DIFFERENTIAL EQUATIONS
Theodore Katsanis (Ph.D. Thesis—Case Inst. of Tech.) Jun. 1967 85 p refs
(NASA-TM-X-52239) CFSTI: HC $3.00/MF $0.65 CSCL 12A

A finite difference method for the solution of symmetric positive linear differential equations is developed. The method is applicable to any region with piecewise smooth boundaries. Methods for solution of the finite difference equations are discussed. The finite difference solutions are shown to converge at essentially the rate $O(h^{1/2})$ as $h \to 0$, h being the maximum distance between adjacent mesh points. An alternate finite difference method is given with the advantage that the finite difference equations can be solved iteratively. However, there are strong limitations on the mesh arrangements which can be used with this method. The Tricomi equation can be expressed in symmetric positive form. Admissible boundary conditions for any region with piecewise smooth boundaries are given, with a wide choice of boundary conditions being possible. A Tricomi equation with a known analytical solution is solved numerically as an illustration of the numerical results which can be obtained. There is strong convergence to the analytical solutions, but pointwise divergence. Smoothing of the solution reduces this, though, and satisfactory numerical results are obtained. Author

N67-18759# Lockheed Missiles and Space Co., Sunnyvale, Calif.
NEW CLASS OF FINITE-DIFFERENCE OPERATIONS
T. S. Zverkina 1966 4 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSR (Moscow), v. 171, no. 1, 1966 p 33–36
CFSTI: HC $3.00

It is known that no stable methods of degree $p \, n + 2$ exist in the class of finite difference methods of integrating systems of ordinary differential equations utilizing one or several formulas such as

$$L_n Y_k = \sum_{i=0}^{n} a_i Y_{k-i} - h \sum_{i=0}^{n} b_i Y'_{k-i} = 0$$

A new class of operators $L_{n\nu}(a)$, dependent on the real parameter a, which contains the customary operators L_n for $a = 0$ and $\nu = n$, is studied. Extension of the class of operators permits a more penetrating study of finite difference methods of integration and the construction of stable methods of elevated degree, in particular, methods of degree 2n. Author

N67-18777# Oak Ridge National Lab., Tenn.
ON SOLVING SYSTEMS OF POLYNOMIALS IN SEVERAL INDETERMINATES
D. C. Ramsey (M. A. Thesis) Oct. 1966 87 p refs
(Contract W-7405-ENG-26)
(ORNL-4008) CFSTI: HC $3.00/MF $0.65

Consider the problem of finding all common zeros of a system $P_i(X_1, X_2, \ldots, X_m)$ for $i = 1, 2, \ldots, n$ where each P_i is a polynomial in the indeterminates $X_1, X_2, \ldots, X_m$. Kronecker devised a method for solving such a system. A system of polynomials (called a resultant system) which contains in its set of common zeros the set of common zeros of the system is found. Such a resultant system consists of a set of polynomials. $R_i(X_1, X_2, \ldots X_m)$ for $i = 1, 2, \ldots, n'$ where $n' \leq n$ and R_j for $j = p+1, p+2, \ldots, n'$ is free of one indeterminate which appears in R_p where $1 \leq p < n'$. The resultant system can be solved by finding solutions to $R_{n'}$ and then working back through $R_{n'-1}$, etc., to find m-tuples that are solutions of the resultant system. Two methods are discussed for arriving at a resultant system for a system of polynomials. A system of computer subroutines were written for manipulating polynomials over a finite field. These subroutines were incorporated into a computer program for finding a resultant system of polynomials (over a finite field) using one of the methods discussed. Author (NSA)

N67-18874# Union Carbide Nuclear Co., Oak Ridge, Tenn. Gaseous Diffusion Plant.
TWO ALGORITHMS FOR COMPUTING THE GENERALIZED INVERSE OF A MATRIX
Bert W. Rust 9 Nov. 1966 41 p refs
(Contract W-7405-ENG-26)
(K-1641) CFSTI: HC $3.00/MF $0.65

The computation of generalized inverses of arbitrary mxn complex matrices is considered. Two methods are discussed and both of them are extensions of well-known methods for inverting non-singular matrices. The first method is based upon the factorization of the matrix which is obtained by orthogonalizing its columns by the Gram–Schmidt process. The second method is based upon a factorization of the matrix obtained by using elementary Hermitian matrices. The use of these techniques for inverting non-singular matrices is first explained and then their extensions to arbitrary mxn matrices is given. Author (NSA)

N67-18884# Argonne National Lab., Ill.
RATIONAL CHEBYSHEV APPROXIMATIONS FOR FERMI–DIRAC INTEGRALS OF ORDERS – 1/2, 1/2, AND 3/2
W. J. Cody and Henry C. Thacher, Jr. May 1966 48 p refs
(Contract W-31-109-ENG-38)
(ANL-7200) CFSTI: HC $3.00/MF $0.65

Rational Chebyshev approximations are given for the complete Fermi–Dirac integrals of orders – 1/2, 1/2, and 3/2. Maximal

relative errors vary with the function and interval considered, but generally range down to 10^{-9} or less. Author (NSA)

N67-18889# Argonne National Lab., Ill. Applied Mathematics Div.
MULTISTEP INTEGER–PRESERVING GAUSSIAN ELIMINATION
Erwin H. Bareiss May 1966 24 p
(Contract W-31-109-ENG-38)
(ANL-7213) CFSTI: HC $3.00/MF $0.65

A method is developed which permits integer–preserving elimination in systems of linear equations, $AX = B$, such that the magnitude of the coefficients in the transformed matrices is minimized, and the computational efficiency is considerably increased in comparison with the corresponding ordinary (single-step) Gaussian elimination. The algorithms presented can also be used for the efficient evaluation of determinants and their leading minors. Explicit algorithms and flow charts are given for the two-step method. The method should also prove superior to the widely used fraction-producing Gaussian elimination when A is nearly singular. Author (NSA)

N67-18921*# National Aeronautics and Space Administration. Washington, D. C.
BOUNDARY-VALUE PROBLEM FOR AN EQUATION OF MIXED TYPE WITH TWO PARABOLIC LINES [OB ODNOY KRAYEVOY ZADACHE DLYA URAVNENIYA SMESHANNOGO TIPA S DVUMYA PARABOLICHLSKIMI LINIYAMI]
N. M. Fleysher Jan. 1967 4 p ref Transl. into ENGLISH from Rev. Roumaine de Math. Pvres et Appl. (France), v. 11, no. 8, 1966 p 699–701
(NASA-TT-F-10474) CFSTI: HC $3.00/MF $0.65 CSCL 12A

Many works have been devoted to boundary value problems for equations of the mixed type with one parabolic line. Below we consider a boundary value problem for mixed equations with two intersecting lines of a degenerate type. Solution is sought in the semi-plane bounded by the characteristic equation. The problem is reduced to a system of singular integral equations whose solution is obtained by the method developed (for the case of one equation). Author

N67-18981*# Florida State Univ., Tallahassee. Dept. of Statistics.
SIMULTANEOUS ESTIMATION BY PARTIAL TOTALS FOR COMPARTMENTAL MODELS
John J. Beauchamp (Oak Ridge Natl. Lab.) and Richard G. Cornell 1 Feb. 1967 25 p refs
(Grants NGR-10-004-029; PHS-5-FI-GM-15-632-03; PHS-5TI-GM-913)
(NASA-CR-82492; TR-10) CFSTI: HC $3.00/MF $0.65 CSCL 12A

An estimation procedure is presented that may be used to simultaneously estimate the parameters in a multiple equation regression model. The regression models considered are shown to arise from radioactive tracer experiments using compartmental models. For such models the regression equations are shown to be linear combinations of the same exponential parameters, and the number of independent regression equations is also shown to be the same as the number of exponential parameters. The estimation procedure is developed under the assumption of equally spaced values of the independent variable. The first step of the procedure involves the simultaneous estimation of the exponential parameters by a generalized partial totals approach, and the second step involves the simultaneous estimation of the linear parameters using the estimates of the nonlinear parameters. Modifications are presented that make the estimation procedure more versatile, and asymptotic properties are also investigated. The procedure is illustrated with generated data. Author

N67-19004# Purdue Univ., Lafayette, Ind. Dept. of Statistics.
THE QUEUE WITH POISSON INPUT AND GENERAL SERVICE TIMES, TREATED AS A BRANCHING PROCESS
Marcel F. Neuts Sep. 1966 35 p refs /tr Mimeograph Ser. No. 92
(Contract Nonr-1100(26))
(AD-640483) CFSTI: HC $3.00/MF $0.65

The MG1 queue is treated as a sequence of branching processes, the duration of which constitutes a busy period. The first generation in each branching process consists of the customers present at the beginning of the busy period, the second generation consists of all customers, who arrive during the service time of the first generation, etc. When the queue becomes idle, the branching process becomes extinct. This approach permits a more elementary treatment of the MG1 queue, without use of Rouches theorem. It provides a natural sequence of approximants to the distributions, which is considered, and it provides a simple derivation of the virtual waitingtime. The paper also considers two random variables of interest, which have not been considered hitherto. One is the total number of customers, served in (o,t), the other is the virtual age or the time already spent in the queue, by the customer in service at time t. A new imbedded semi-Markov process is considered, and a study is made of its asymptotic behavior. Author (TAB)

N67-19029*# Lockheed Missiles and Space Co., Huntsville, Ala. Huntsville Research and Engineering Center.
RESEARCH IN STABILITY OF PERIODIC MOTIONS Quarterly Progress Report, 5 Aug.–4 Nov. 1966
John White 4 Nov. 1966 15 p refs
(Contract NAS8-20323)
(NASA-CR-82480; LMSC/HREC-A783467) CFSTI: HC $3.00/MF $0.65 CSCL 12A

Background material studied for application to investigating the stability of periodic motion is summarized. Particular emphasis was placed on the stability of a mapping and the concept of stability as specialized to conservative systems. Measure preserving mappings, the normal form of the Hamiltonian, and Poincare's recurrence theorem are discussed in relation to the stability problem. Plans for future work are also outlined. L.E.W.

N67-19035*# California Univ., Berkeley.
NO TITLE Semiannual Status Report
[1967] 4 p refs
(Grant NGR-05-010-008)
(NASA-CR-82472) CFSTI: HC $3.00/MF $0.65 CSCL 12A

A summary report is given of work done with an on-line computer to determine ways of numerically solving nonlinear singular equations, which arose during investigation of the deformation of an elastic circular cylinder in a two-dimensional ideal fluid flow. Investigation of the reflection laws of systems of elliptic equations across a straight line on which general analytical linear boundary conditions are given is summarized, and the reduction of the electrostriction problem is mentioned. L.E.W.

N67-19038*# Florida State Univ., Tallahassee. Dept. of Statistics.
SPEARMAN SIMULTANEOUS ESTIMATION FOR A COMPARTMENTAL MODEL Technical Report No. 9
John J. Beauchamp and Richard G. Cornell (Oak Ridge Natl. Lab.) [1966] 23 p refs
(Grants NGR-10-004-029; PHS-G-5FI-GM-15632-03)
(NASA-CR-82474) CFSTI: HC $3.00/MF $0.65 CSCL 12A

A compartmental model is presented for tracer experiments with a fixed and known amount of tracer material which is injected initially into a single compartment and accumulates in another compartment. The model could also arise as a description of chemical reactions. The model is represented as a system of linear combinations of exponentials with common exponential parameters. Then a simultaneous estimation procedure is developed for this model under the assumption that the values of the independent

variable in the model are equally spaced on a logarithmic scale. Asymptotic properties of the estimation procedure are investigated and an example is given. Author

N67-19089*# Maryland Univ., College Park. Computer Science Center.
ON A GENERAL THEORY OF CHARACTERISTICS AND THE METHOD OF INVARIANT IMBEDDING
Gunther H. F. Meyer Dec. 1966 119 p refs
(Grant NsG-398)
(NASA-CR-82509; TR-66-37) CFSTI: HC $3.00/MF $0.65 CSCL 12A

A new derivation of the equations of invariant imbedding for transport problems is presented. Such problems, which take on the form of two point boundary value problems for two abstract ordinary differential equations, are to be transformed into initial value problems. For this, a general theory of characteristics is developed, which then is applied to establish the equivalence between the two ordinary differential equations--considered as characteristic equations--and an abstract partial differential equation. Furthermore, an imbedding of the given boundary value problem into a family of initial value problems now leads to a Cauchy problem for this partial differential equation, whose solution yields an additional boundary value for the original problem, thus transforming it into an initial value problem. Finally, it is shown that the abstract partial differential equation is the underlying imbedding equation which, for transport problems, reduces to the known equations derived with the method of invariant imbedding. Author

N67-19100*# Pittsburgh Univ., Pa. Dept. of Electrical Enginering.
THE STABILITY THEORY OF SOLUTIONS TO PARTIAL DIFFERENTIAL EQUATIONS: A BIBLIOGRAPHICAL SURVEY
Gabe R. Buis and William G. Vogt 31 Jan. 1967 21 p refs
(Grant NGR-39-011-039)
(NASA-CR-82662) CFSTI: HC $3.00/MF $0.65 CSCL 12A

A bibliographical survey of recent contributions to the stability theory of solutions to partial differential equations is reported. Although some results employing approximate methods are mentioned, the main emphasis is on the use of Lyapunov's Direct Method. Closely related results on the existence and uniqueness of solutions to partial differential equations employing the theory of distributions or generalized functions are also given. Author

N67-19111*# Texas Univ., Austin. Engineering Mechanics Research Lab.
OPTIMIZATION OF NONLINEAR SYSTEMS WITH INEQUALITY CONSTRAINTS
Gary J. Lastman Dec. 1966 133 p refs
(Grant NsG-551)
(NASA-CR-82662; EMRL-TR-1006) CFSTI: HC $3.00/MF $0.65 CSCL 12A

Reported is a study designed to determine the effect of inequality constraints on the optimization of dynamical systems described by first order ordinary differential equations, which are usually nonlinear; and to provide a computational algorithm that can be used to obtain a solution to the resulting two-point boundary value problem. Two general forms of inequality constraints were examined: C(X,U,t), which explicitly involved the control, and S(X,t), the state-variable constraint, which did not. It was shown that the control could be readily determined so that the trajectory would not cross constraint boundary of the form C(X,U,t) = 0. On a state variable constraint boundary, S(X,t) = 0, the control was chosen to satisfy $d^qS/dt^q = 0$, where the q-th derivative of S is the first one that explicitly contains the control. A general problem involving inequality constraints, C(X,U,t) = 0, and intermediate boundary conditions was studied to obtain the relationships which govern its solution. It was found that whenever p of the constraints were simultaneously zero, then $p \leq m$, where m is the number of control variables, U_j. A new perturbation method for inequality constrained problems was devised to handle the two-point boundary value problem. Also devised was a simple test for the existence of points to conjugate to the initial time t_0. S.C.W.

N67-19154*# Texas A&M Univ., College Station. Dept. of Mathematics.
EXPLICIT INTEGRATION OF DIFFERENTIAL EQUATIONS
S. A. Sims [1966] 3 p refs
(Grant NGR-44-001-024)
(NASA-CR-82571) CFSTI: HC $3.00/MF $0.65 CSCL 12A

A polynomial $Y_d(x)$ is found which approximates the solution to the differential equation: $Y' = F(x,y)$, $Y(x_0) = A$ in the interval $x_0 \leq x \leq x_0 + h$. The procedure employed is somewhat similar to Runge-Kutta methods and may be a special case thereof. Author

N67-19173 Lockheed Missiles and Space Co., Palo Alto, Calif.
FINITE DIFFERENCE METHOD FOR A FIRST ORDER NONLINEAR EQUATION WITH MANY INDEPENDENT VARIABLES
S. N. Kruzhkov [1966] 12 p refs Transl. into ENGLISH from Zh. Vychislitel'noi Mat. i Mat. Fiz. (Moscow), v. 6, no. 5, 1966 p 884-894

This paper is closely connected with the author's work where a method is proposed for the foundation of approximate methods of solving the nonlinear equation

$$u_t + f(t,x,u,u_x) = 0,$$

$$x = (x_1, \ldots, x_n), \quad u_t = \frac{\partial u}{\partial t}, \quad u_x = \left(\frac{\partial u}{\partial x_1}, \ldots, \frac{\partial u}{\partial x_n}\right),$$

with the initial condition (1) (2)

$$u|_{t=0} = u_0(x)$$

and existence and uniqueness theorems are proved for the generalized solution of the Cauchy problem for (1) and (2). This method is applied herein for the foundation of a finite-difference method of solving the problem (1), (2) with a scheme which is a generalization of a well-known scheme; and an error estimate for the approximate solution is given. An analogous result for a quasi-linear equation with one space variable has been obtained by another method. Author

N67-19198 Lockheed Missiles and Space Co., Palo Alto, Calif.
FIRST MEMBERS OF THE ASYMPTOTIC FOR THE PROBABILITY OF NO EXCURSION OF A RANDOM PROCESS BEYOND AN INCLINED LEVEL
R. N. Minoshin [1966] 4 p refs Transl. into ENGLISH from Vestn. Leningr. Uni Univ., Ser. Mat., Mekh. i Astron. (Leningrad), no. 19, 1966 p 99-102

Several theorems are derived for a stationary (in the broad sense), differentiable with probability one, random process x(t) with zero mean and correlation function B(t). In some of the problems considered, it is required to evaluate a given continual integral expression. L.S.

N67-19218*# Pittsburgh Univ., Pa. Dept. of Electrical Engineering.
CONSTRUCTION OF THE YAPUNOV FUNCTION FOR A CASE OF STABILITY WITH CONSTANTLY ACTING DISTURBANCES IN NONLINEAR SPACES [POSTROENIE FUNKTSII LIAPUNOVA DLIA ODNOGO SLUCHAIA USTOICHIVOSTI PRI POSTOLANNO DEISTVUIUSHCHIKH VOZMUSHCHENILAKH V NELINEINYKH PROSTRANSTVAKH]
Kh. I. Ibreshev 1 Jan. 1967 11 p refs Transl. into ENGLISH from Vestn. Acad. Nauk Kaz. SSR (Alma-ata), v. 22, Jan. 1966 p 42-46
(Grant NGR-39-011-039)
(NASA-CR-82589) CFSTI: HC $3.00/MF $0.65 CSCL 12A

Presented are results of a theoretical analysis in which the Second Method of Lyapunov is used to prove that the null solution $x = \Theta$ of the differential equation (without disturbance)

$$\frac{dx}{dt} = f(t,x) + \psi(t,x)$$

is stable for any small constantly acting disturbance $\phi(t,x)$, if the solution $X = X(t,t_0,x_0)$, going through the point (t_0,x_0) and L of the differential equation

$$\frac{dx}{dt} = f(t,x) + \psi(t,x) + \phi(t,x)$$

satisfies the following condition: for any given $\epsilon>0$ and for any given initial time $t_0 \geq 0$ there exist two numbers $r = r(\epsilon,t_0)>0$ and $\rho = \rho(\epsilon,t_0)>0$ such that

$$||x_0||_L \leq r \text{ and } ||\phi(t,x)||_L \leq \rho$$

implies that for all $t \geq t_0$

$$||X(t,t_0,x_0)||_L \leq \epsilon$$

It is further considered that for specific problems $\epsilon < R$. S.C.W.

N67-19222# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

A NUMERICAL SOLUTION FOR QUASILINEAR EQUATIONS OF PARABOLIC TYPE

D. G. Gordeziani 18 Aug. 1966 12 p ref Transl. into ENGLISH from Akad. Nauk Gruzin. SSR, Soobshch. (Tiflis), v. 37, no. 1, 1965 p 3-10

(FTD-TT-65-2003; TT-67-60343; AD-644561) CFSTI: HC $3.00/MF $0.65

This paper deals with the construction and investigation of plain-finite schemes of high accuracy for the problem (1.1)-(1.2). TAB

N67-19226# Boeing Scientific Research Labs., Seattle, Wash. Mathematical Research Lab.

A MULTIVARIATE NOTION OF ASSOCIATION, WITH A RELIABILITY APPLICATION

J. D. Esary, Frank Proschan, and D. W. Walkup Oct. 1966 26 p refs /ts Math. Note No. 484

(D1-82-0567; AD-644094) CFSTI: HC $3.00/MF $0.65

Random variables T1,T2,...,Tn are, in this paper, associated if each pair of non-decreasing functions F(T1,T2,...,Tn), G(T1,T2,...,Tn) have a non-negative covariance. Association holds in cases ranging from T1,T2,...,Tn independent to T1,T2,...,Tn jointly restricted to a non-decreasing curve. Association is preserved under the standard multivariate operations of extracting subsets and pooling independent sets; and under the special operation of forming sets of non-decreasing functions. Suitable choices of F,G lead to various inequalities for associated random variables. The properties of association are studied in the simple, but representative, case that T1,T2,...,Tn are finitely discrete. The notion of association is useful in extending the domain of validity of the minimal cut lower bound for the reliability of a coherent system, notably (here) to the case of repairable components with exponential times to failure and exponential times to repair. Author (TAB)

N67-19255# Bureau of Mines, Amarillo, Tex. Helium Research Center.

NONLINEAR REGRESSION AND THE PRINCIPLE OF LEAST SQUARES: A METHOD OF EVALUATING THE CONSTANTS AND A NEW METHOD FOR CALCULATING VARIANCES AND COVARIANCES

Robert E. Bariseau and B. J. Dalton 1967 30 p refs

(BM-RI-6900)

This report gives the principles of the method used when solving nonlinear-regression problems, and contains the mathematical equations necessary to accomplish the following objectives: the evaluation of the parameters in such a way that the sum of the weighted squares of the residuals of an experimental observable is a true minimum, regardless of the functional relationship between the variables and these parameters; and the evaluation of all variances and covariances of the parameters by means of the usual approximation of the law for the propagation of errors. Author

N67-19265# United Kingdom Atomic Energy Authority, Culham (England).

INVARIANTS OF NEARLY PERIODIC HAMILTONIAN SYSTEMS

B. McNamara and K. J. Whiteman Jul. 1966 35 p refs Submitted for publication

(CLM-P-111) CFSTI: HC $3.00/MF $0.65

A new and simple method of finding an invariant, J, of a nearly periodic dynamical system is presented. The Hamiltonian is written as $H = p_1 + \epsilon\Omega(q_1,p_1)$, where Ω is periodic in q_1 and $\epsilon << 1$. The first four terms of the invariant series are found explicitly in terms of Ω using Poisson Bracket and averaging operators. This invariant is related to the adiabatic invariant and to various constants of motion discussed in celestial mechanics, such as Whittaker's adelphic integral. J is shown to be an asymptotic constant by using the rigorous methods of Kruskal (1962) to calculate the adiabatic invariant K; it is found that $K/\tau = H - \epsilon J$, where τ is the period in q_1. The adelphic integral has different functional forms depending on the presence of resonant denominators but is shown to be always a function of H and J. The present method provides a single functional form which is even applicable when Ω is only almost periodic in q_1. It is also much simpler than the methods of adiabatic invariant theory. Some examples are discussed here where several terms of the series are required to achieve agreement near periodic orbits. Author

20 METEOROLOGY

Includes climatology; weather forecasting; and visibility studies. For related information see also: 13 Geophysics; and 30 Space Sciences.

N67-18210# Federal Aviation Agency, Atlantic City, N. J. Test and Evaluation Div.

EVALUATION OF THE WEATHER INFORMATION REMOTING AND DISPLAY SYSTEM Final Report

Anthony D. Bradley Nov. 1966 27 p

(RD-66-81)

An evaluation of the weather information remoting and display system (WIRDS) was conducted to determine a system performance level which would permit an effective operational evaluation. The system was designed to process weather surveillance radar weather information and present iso-amplitude contours and annotations on the air traffic controller's (ATC) display. It was concluded that the information presented by the WIRDS would interfere with ATC procedure by introducing ground clutter and aircraft targets onto the RBDE-5 display. Author

N67-18235# Stanford Research Inst., Menlo Park, Calif.

TECHNIQUES FOR DETERMINING A WORLD-WIDE CLIMATOLOGY OF TURBULENCE THROUGH USE OF METEOROLOGICAL DATA

Roy M. Endlich, R. L. Mancuso, and J. W. Davies May 1966 65 p refs
(Contract AF 19(628)-5173)
(AFCRL-66-355; SR-1; AD-634154) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. SOME AIRCRAFT OBSERVATIONS OF JET-STREAM AND MOUNTAIN-WAVE TURBULENCE R. M. Endlich p 5–16 refs (See N67-18236 08-20)

2. STATISTICAL RELATIONSHIPS BETWEEN CLEAR-AIR TURBULENCE AND UPPER-LEVEL WIND AND TEMPERATURE PATTERNS R. L. Mancuso and R. M. Endlich p 17–41 refs (See N67-18237 08-20)

3. THE FEASIBILITY OF MEASURING TURBULENCE IN THE FREE ATMOSPHERE FROM RISING BALLOONS TRACKED BY FPS-16 RADAR R. M. Endlich and J. W. Davies p 43–62 refs (See N67-18238 08-20)

N67-18236# Stanford Research Inst., Menlo Park, Calif.
SOME AIRCRAFT OBSERVATIONS OF JET-STREAM AND MOUNTAIN-WAVE TURBULENCE
Roy M. Endlich *In its* Tech., for Determining a World-Wide Climatology of Turbulence Through Use of Meteorol. Data May 1966 p 5–16 refs (See N67-18235 08-20) CFSTI: HC $3.00/MF $0.65

Clear-air turbulence measured by aircraft has been correlated with concurrent meteorological measurements, and relates well to the mesoscale horizontal wind direction shear computed along an axis normal to the upper flow. Recent measurements of mountain-wave turbulence by aircraft are reviewed and combined with mountain-wave structure known from previous studies. In a well-developed wave, a hydraulic jump occurs downstream from the foot of the lee slope of the mountains. The boundary layer is generally capped by a temperature inversion. At the base of the inversion layer, shear-gravity waves and mechanical effects may combine so that extreme turbulence may exist. At slightly higher altitudes (above the inversion) smooth drafts generally prevail. The tropopause layer may also contain severe turbulence when the jet stream and a sharp upper trough combine with a mountain wave. Data from a few U-2 flights show that severe turbulence may exist in certain stratospheric layers above the wave. Author

N67-18237# Stanford Research Inst., Menlo Park, Calif.
STATISTICAL RELATIONSHIPS BETWEEN CLEAR-AIR TURBULENCE AND UPPER-LEVEL WIND AND TEMPERATURE PATTERNS
R. L. Mancuso and Roy M. Endlich *In its* Tech. for Determining a World-Wide Climatology of Turbulence Through Use of Meteorol. Data May 1966 p 17–41 refs (See N67-18235 08-20) CFSTI: HC $3.00/MF $0.65

The probability is determined that an aircraft will encounter moderate or severe high-level turbulence during a 100-mile flight segment when particular values of certain meteorological quantities exist in that locality. Several meteorological quantities were correlated with turbulence frequencies and useful correlations were found with vertical wind direction shear, vertical vector shear, and horizontal resultant deformation. The product of wind shear and deformation gave a correlation with turbulence frequency of 0.45, the highest value found so far. The meteorological data over the United States were analyzed for February 1963 to determine the values of wind shear, deformation, etc., at each location and altitude. These values were inserted in the regression equations to obtain a computed turbulence climatology. The March 1962 data were used as an independent test. For both periods the computed values agree reasonably well with the observed turbulence climatologies. A final portion of the investigation revealed that for given meteorological conditions, turbulence frequencies are somewhat higher over mountains that over level terrain, as expected. Author

N67-18238# Stanford Research Inst., Menlo Park, Calif.
THE FEASIBILITY OF MEASURING TURBULENCE IN THE FREE ATMOSPHERE FROM RISING BALLOONS TRACKED BY FPS-16 RADAR
Roy M. Endlich and J. W. Davies *In its* Tech. for Determining a World-Wide Climatology of Turbulence Through use of Meteorol. Data May 1966 p 43–62 refs (See N67-18235 08-20) CFSTI: HC $3.00/MF $0.65

On passing through an atmospheric layer that contains random isotropic turbulent eddies, one would expect that a rising balloon would follow an erratic path. Missile-tracking radar has been used to follow the paths of special balloons that have only small self-induced oscillatory motions. After smoothing the slant-range measurements of the radar, we have computed and plotted range deviations, and these reveal both self-induced motions and occasional turbulent layers. By this technique turbulence can be measured from low levels into the stratosphere, and can be correlated with concurrent wind measurements. Moreover, costs of obtaining measurements are relatively low. Ten flights of "Jimspheres" have been processed so far, and further investigation is planned. Author

N67-18253*# National Severe Storms Lab., Norman, Okla.
TURBULENCE IN CLEAR AIR NEAR THUNDERSTORMS
Dec. 1966 26 p refs
(NSSL-30) CFSTI: HC $3.00/MF $0.65 CSCL 04B

CONTENTS:

1. SOME RESULTS OF A STUDY OF ATMOSPHERIC TURBULENCE IN CLEAR AIR ABOVE THUNDERSTORMS AND OF ITS RELATIONSHIP TO WEATHER RADAR PICTURES J. Burnham and C. S. Spavins p 1–9 ref (See N67-18254 08-20)

2. AN ATMOSPHERIC DISTURBANCE ENCOUNTERED BY A CANBERRA OVER STORMS AT OKLAHOMA ON MAY 27, 1965 T. W. Harrold (Meteorol. Office) and A. Burns p 11–20 refs . (See N67-18255 08-20)

N67-18254*# Royal Aircraft Establishment, Bedford (England).
SOME RESULTS OF A STUDY OF ATMOSPHERIC TURBULENCE IN CLEAR AIR ABOVE THUNDERSTORMS AND OF ITS RELATIONSHIP TO WEATHER RADAR PICTURES
Jack Burnham and Clifford S. Spavins *In* Natl. Severe Storms Lab. Turbulence in Clear Air Near Thunderstorms Dec. 1966 p 1–9 ref (See N67-18253 08-20) CFSTI: HC $3.00/MF $0.65

Derived gust velocities up to 20 ft./sec. and indicated airspeed fluctuations up to 34 ft/sec. have been measured during flight through clear air at altitudes between 40,000 ft. and 45,000 ft. in thunderstorm areas. The possible use of weather radar to avoid such disturbances is discussed. Author

N67-18255# Royal Aircraft Establishment, Farnborough (England).
AN ATMOSPHERIC DISTURBANCE ENCOUNTERED BY A CANBERRA OVER STORMS AT OKLAHOMA ON MAY 27, 1965
Anne Burns and Terence W. Harrold (Meteorol. Office, Malvern Eng.) *In* Natl. Severe Storms Lab. Turbulence in Clear Air Near Thunderstorms Dec. 1966 p 11–20 refs (See N67-18253 08-20) CFSTI: HC $3.00/MF $0.65

In clear air over the top of a group of storms, a Canberra aircraft encountered rapid changes in temperature and horizontal airflow and moderate to severe turbulence. An explanation involving the deflection of the wind over the storm tops may account for the aircraft observations. The disturbance is discussed as a potential cause of aircraft upsets. Author

N67-18538# Brookhaven National Lab., Upton, N. Y. Instrumentation and Health Physics Dept.
ENVIRONMENTAL MONITORING OF ^{131}I AS A VERIFICATION OF METEOROLOGICAL CALCULATIONS OF DISPERSION FROM A 100 METER STACK
A. P. Hull and M. E. Smith [1966] 27 p refs Presented at the 1st Intern. Congr. of the Intern. Radiation Protect. Assn., Rome
(Contract AT(30-2)-GEN-16)
(BNL-10527; CONF-660920-3) CFSTI: HC $3.00/MF $0.65

On March 1, 1965 an overheated sample resulted in the release of 100 mC of ^{131}I and about 1.0 C of ^{133}I from a 100-m stack. Measurements of activity at monitoring stations located from 0.7 to 2.5 km from the stack, meteorological parameters, data on known emission from the stack, estimations of ground-level concentrations, and $^{133}I/^{131}I$ ratios were used to revise estimates on the rise of the plume above the stack and for the verification of estimated environmental contamination for periods from days to years. The measurements of radioactivity at various sites revealed important features of the plume and of dispersion patterns at the site. NSA

N67-18660*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A PRELIMINARY REPORT ON BIDIRECTIONAL REFLECTANCES OF STRATOCUMULUS CLOUDS MEASURED WITH AN AIRBORNE MEDIUM RESOLUTION RADIOMETER
G. T. Cherrix and B. A. Sparkman Feb. 1967 38 p refs
(NASA-TM-X-55659; X-622-67-48) CFSTI: HC $3.00/MF $0.65
CSCL 04B

Bidirectional reflectances of three stratocumulus clouds were measured with the two visible channels, (0.55 to 0.85μ, and .2 to 4μ), of an airborne medium resolution (infrared) radiometer. These measurements were made in five azimuth directions with respect to the principal plane of the sun. Values of bidirectional reflectances obtained agree well with those expected from Mie scattering theory. The albedo of each stratocumulus cloud was derived by summing bidirectional reflectances over a hemisphere. Author

N67-18691*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
SPECTRAL MEASUREMENTS FROM 1.6 TO 5.4 MICRONS OF NATURAL SURFACES AND CLOUDS
W. A. Hovis, Jr. and M. Tobin Jan. 1967 16 p refs
(NASA-TM-X-55662, X-622-67-18) CFSTI: HC $3.00/MF $0.65
CSCL 04B

A spectrometer, utilizing an interference filter wedge, has been used to obtain spectra of reflected solar and emitted thermal radiation from earth in the wavelength interval 1.6 to 5.4μ. Measurements were made, from a jet aircraft, of characteristic spectra of a wide variety of surface and cloud conditions during day and night flights. Measurements made concurrently from the airplane and the Nimbus II meteorological satellite verified the accuracy of the Nimbus measurements. Author

N67-18717 Finnish Meteorological Office, Helsinki.
CLIMATOLOGICAL DATA FROM JOKIOINEW AND SODANKYLAE OBSERVATORIES, 1964 [JOKIOSTEN JA SODANKYLAEN OBSERVATORIOIDEN ILMASTOHAVAINNOT, 1964]
1966 51 p In ENGLISH and FINNISH
CFSTI: $3.00 $3.00 CSCL 04B

This volume contains the results of observations made by the meteorological observatories of Jokioinen and Sodankyla in 1964. It gives the values obtained from recordings of atmospheric pressure, temperature, relative humidity, wind direction and speed at even hours, also the amount of sunshine and cloud, including cloud formation and height, hydrometeors observed with time of appearance visibility and precipitations. Author

N67-18727*# National Aeronautics and Space Administration, Washington, D. C.
SATELLITE METEOROLOGY
William C. Spreen, Robert H. McQuain, and George Tennyson, Jr. *In its* Significant Achievements in Space Appl., 1965 1966 p 17-85 refs (See N67-18724 08-31) GPO: HC $0.45; CFSTI: MF $0.65

Research based on satellite TV cloud pictures provided additional criteria for correlating cloud-cover picture data with cyclogeneeis. Radiation measurements by satellites gave information on the global distribution of energy sources and sinks and the heat budget of the earth-atmosphere system. Meteorological sounding rockets were used to obtain data on polar winter nights, stratospheric warming events, noctilucent clouds, the fine-grain structure of high-altitude winds, and the fall transition period at these altitudes. Scientific results obtained from development-type rockets included: (1) the possible existence of a pronounced semiannual cycle in the zonal wind component of 40 kilometers and above; (2) diurnal and semidiurnal oscillations observed with the largest amplitude near 45 kilometers; and (3) a stratospheric tidal jet which followed the seasonal reversal at the spring pole and makes known a possible data bias due to the scheduling of rocket observations near local noon. G.G.

N67-18739*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A QUASI-GLOBAL ANALYSIS OF TROPOSPHERIC WATER VAPOR CONTENT FROM TIROS IV RADIATION DATA
Ehrhard Raschke (Munich Univ.) and William R. Bandeen 1 Sep. 1966 42 p refs
(Grant NsG-305)
(NASA-TM-X-55686; X-622-66-501) CFSTI: HC $3.00/MF $0.65
CSCL 04B

Coordinated measurements of the earth's radiation to space within the 6.3μ band of water vapor and the 8-13μ atmospheric window were analyzed to infer the spatial and temporal variations, on a quasi-global scale, of the following three quantities: (1) the mean relative humdity of the upper troposphere, (2) the mean effective temperature of the cloud top, land, or ocean surfaces, and (3) in conjunction with radiosonde temperature data, the water vapor mass above the 500 mb level. The results show major regions of high moisture content over South America, Central Africa, and the western Pacific Ocean near the Intertropical Convergence Zone, plus several less prominent moist regions near the polar frontal zones in both hemispheres. At equatorial latitudes the average surface temperatures exhibit a persistent minimum along a narrow band identified with the Intertropical Convergence Zone. The distribution pattern of water vapor mass above 500 mb strongly follows the 500 mb temperature field. Near the equator 0.3-0.4 gm cm^{-2} of precipitable water vapor are found, while in middle latitudes on the average only 0.02-0.04 mg cm^{-2} present in the upper troposphere. Author

N67-18952*# Weather Bureau, Silver Spring, Md.
SOUTHERN HEMISPHERE STRATOSPHERIC CIRCULATION AS INDICATED BY SHIPBOARD METEOROLOGICAL ROCKET OBSERVATIONS
Frederick G. Finger and Harold M. Woolf Washington, NASA, Mar. 1967 23 p refs
(NASA-TM-X-1346) CFSTI: HC $3.00/MF $0.65 CSCL 04B

Meteorological data from the NASA mobile launch expedition are utilized to investigate the early autumn stratospheric circulation of the Southern Hemisphere. Time-height and cross section analyses indicate the vertical and areal extent of the developing winter-time polar vortex. A comparison is made between this cyclone and that of the Northern Hemisphere at a similar stage of development. Additional sets of analyses illustrate segments of the circulation patterns in both hemispheres along the 78th meridian at the time periods of the observations. Author

N67-19176# France. Direction de la Meteorologie Nationale, Paris.
THE CLIMATE OF IRAN [CLIMATS DE L'IRAN]
Chafi Djavadi (Ph.D. Thesis—Paris Univ., 1964) Aug. 1966 103 p refs In FRENCH *Its* Monograph No. 54
CFSTI: HC$3.00/MF$0.65

Climatic phenomena in Iran are considered in a series of monographs dealing with atmospheric movements, precipitation temperature, and humidity. Condiditions in the hot, temperate, and cold regions of the country are discussed; and the great contrasts in precipitation in these diverse geographical areas are treated. Attention is given to the classification of the types of climates found in Iran, specifically according to humidity and dryness. These climate types are summarized graphically, as are the findings of the meteorological stations throughout the country. Transl. by M.W.R.

N67-19232# Emmanuel Coll., Boston, Mass. Oriental Science Library.
A BAROTROPIC MODEL WITH ACCOUNT OF LARGE-SCALE OROGRAPHIC INFLUENCES
Tung-hsien Liao, Hung-teh Liu, and Yo-fang Li Bedford, Mass., AFCRL, Oct. 1966 14 p refs Transl. into ENGLISH from Ch'i Hsiang Hsueh Pao (Peking), v. 31, no. 3, 1961 p 234–240
(Contract AF 19(628)-5073)
(EMM-66-65; TT-67-60350; AD-644566) CFSTI: HC $3.00/MF $0.65

The paper presents a linearized barotropic prognostic equation and its approximate solution with the effect of orography taken into consideration. It is found that when the characteristic frequency of a forced disturbance induced by orography is equal to that of a free disturbance, a resonance phenomenon occurs. In this case, the solution obtained may not be used for mid- or long-range prediction. However, this difficulty can be overcome if the frictional effect is introduced. Author (TAB)

N67-19253# Colorado State Univ., Fort Collins. Dept. of Atmospheric Science.
AN APPRAISAL OF TIROS III RADIATION DATA FOR SOUTHEAST ASIA
U. Radok Aug. 1966 40 p refs *Its* Atmospheric Sci. Paper No. 102
(Grant WBG-61)

A short period of Tiros III radiation observations and concurrent synoptic data for Southeast Asia have been examined, as an experiment in the use of satellite radiation data. The areas of low radiation, are found to be in reasonable agreement with dynamic and general meteorological expectations. A slight association is established between low radiation intensity and the occurrence of heavy rain, especially for occasions when the satellite passed after the rainfall had been most intense. For the regions of intermediate radiation intensity, consitituting the largest part of all radiation fields, it is suggested that the "texture" of the smoothed radiation surface is determined primarily by the geometry of the cloud fields viewed. A simple calculation suggests that this effect is much more significant than limb darkening, and that its consideration may add significantly to the value of satellite radiation measurements as a meteorological tool, especially in tropical regions. Author

21 NAVIGATION

Includes guidance; autopilots; star and planet tracking; inertial platforms; and air traffic control. For related information see also: 07 Communications.

N67-18313*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ADVANCED TEST TECHNIQUES
T. P. Cerney and R. Lawrence *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 37–41 refs (See N67-18301 08-34) CFSTI: HC$3.00/MF$0.65

Summarized are results of a cumulative evaluation of circuit testing techniques which will predict incipient failure of a spacecraft circuit or function. Investigated were voltage margin tests, infrared scanning of circuits, and RF noise spectra measurements. These testing techniques were evaluated using a digital system which cycles through a short operational routine. Individual printed circuit cards as well as the complete system were used in the evaluation. Also, analog circuit cards and integrated circuit cards are being evaluated using these test techniques. The circuit cards for the digital test system were temperature cycled through the simulated aging process. The assembled digital test circuit was subjected to four system voltage margin tests, four infrared scanning tests, and three noise-signature system tests. Results showed that there is little detectable drift within the digital test circuit. Activities also included literature searches in the area of infrared testing and pre-indicators of component failures. S.C.W.

N67-18314*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
IMAGE DISSECTOR TUBE DEVELOPMENT
D. S. Herman *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 42–47 (See N67-18301 08-34) CFSTI: HC $3.00/MF$0.65

Efforts to eliminate inherent problem areas associated with the all electrostatic image dissector vacuum tube which will be used in the Canopus sensor for the Mariner Venus 1967 mission are discussed. Focused upon are those areas which create certain constraints on the external optical system as well as prevent the tube from operating at its maximum efficiency. Analyzed are studies focusing on the elimination of such problem areas as long-term stability, short-term drift stability, resolution, pincushion distortion of the image, and sterilization. S.C.W.

N67-18316*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
APPROACH GUIDANCE FLIGHT FEASIBILITY DEMONSTRATION
F. R. Chamberlain and L. J. Barone *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 48–49 (See N67-18301 08-34) CFSTI: HC$3.00/MF$0.65

The initiation of efforts focusing on subsystem, hardware, and software design for a flight feasibility demonstration of spacecraft-based optical approach guidance aboard the Mariner Mars 1969 spacecraft is reported. Approach guidance is a technique whereby increased accuracy of trajectory prediction is achieved during a period of several days prior to planet encounter (closest approach) and subsequently utilized during this period for guidance purposes in trajectory alteration. During the flight feasibility demonstration of the approach guidance concept, it is intended that the Approach Guidance Subsystem (A/G) will track Mars during a 10-day period that ends about 0.5 days before encounter. The approach guidance software used in the Space Flight Operations Facility (SFOF) will perform the functions of spacecraft orbit determination (trajectory prediction), dummy maneuver computation, and post-encounter performance evaluation. Preliminary design of an approach guidance subsystem is in progress. Potential applications include use of a proven approach guidance system to increase the accuracy of either the approach trajectory or an insertion maneuver for a planetary orbiter. An on-board computer may be introduced to eliminate the requirement for telemetry and ground processing as a series part of the guidance process. S.C.W.

N67-18405*# Autonetics, Anaheim, Calif.
STUDIES IN PREDICTOR DISPLAY TECHNIQUE Final Report

J. S. Sweeney, N. C. Todd, and E. C. Heaton Oct. 1965 137 p refs
(Contract NAS2-2166A)
(NASA-CR-73068; C5-1819/3111) CFSTI: HC $3.00/MF $0.65 CSCL 17G

A series of studies were conducted at Autonetics, NAA covering the utility of the predictor display in: (1) manual control of altitude and (2) in monitoring the performance of an automatic flight control system in the pitch axis. The effect of prediction time ahead of the aircraft in the pitch axis was examined by analytical and simulation study. Results are presented indicating that while the predictor display is an effective means for monitoring AFCS flight and for manual flight control in the pitch axis, the mechanization complexity is a formidable barrier to practical realization of the concept. An alternate synthetic prediction system is discussed. Author

N67-18445*# National Aeronautics and Space Administration, Washington, D. C.
TRANSMISSION OF CHARACTERISTIC DATA AND RANGE MEASUREMENT IN AIR-TRAFFIC CONTROL
T. Feger Sep. 1966 37 p refs Transl. into ENGLISH of the Report "Kenndatenuebertragung und Entfernungsmessung bei Flugzeugen" 1965 Rept.-65-63
(NASA-TT-F-10261) CFSTI: HC $3.00/MF $0.65 CSCL 17G

Within the scope of general studies on the automation of air-traffic control, the Institute for Aviation Radio and Microwaves has developed a simple system for measuring the range between ground control stations and aircraft and a system of data transmission from the aircraft to ground stations. The operating principles of the systems have been tested and this report describes the technical details of the test arrangements for both the systems. It further includes systems analysis studies on the possibilities and the practicability of these accessory devices in present and future air-traffic control systems. Author

22 NUCLEAR ENGINEERING

Includes nuclear reactors and nuclear heat sources used for propulsion and auxiliary power. For basic research see: 24 Physics, Atomic, Molecular, and Nuclear. For related information see also: 03 Auxiliary Systems; and 28 Propulsion Systems.

N67-18202# Aerojet-General Nucleonics, San Ramon, Calif.
ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM, ML-1-II FUEL ELEMENT DESIGN REPORT
R. E. Soulis, W. F. English, L. A. Kimura, T. P. Wilcox, and G. W. Titus Jan. 1966 232 p refs
(Contract AT(10-1)-880)
(AGN-TM-415) CFSTI: HC $3.00/MF $0.65

The developmental and analytical activities associated with the design of the fuel elements for the second core loading (ML-1-II) for the ML-1 reactor are summarized. The design is presented in drawings and a tabulation of design characteristics. The analyses performed to evaluate the design are discussed. The performance specification for the ML-1-II fuel elements and a complete list of fabrication drawings are presented in the appendixes. The mechanical design calculations are also reproduced in the appendix. NSA

N67-18221# Wissenschaftliche Gesellschaft fur Luft- und Raumfahrt, Cologne (West Germany).
REPORT ON THE MEETING OF THE WGLR COMMITTEE ON NUCLEAR ENERGY IN AEROTECHNOLOGY, 8–9 DECEMBER IN STUTTGART [BERICHT UBER DIE SITZUNG DES WGLR-FACHAUSSCHUSSES KERNENERGIE IN DER FLUGTECHNIK AM 8./9. DEZEMBER 1965 IN STUTTGART]
Jun. 1966 109 p refs In GERMAN and ENGLISH
(DLR-MITT.-66-07) CFSTI: HC $3.00/MF $0.65

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10. AN EVALUATION OF FAST REACTOR POWER PLANTS FOR SPACE APPLICATIONS W. Balz, G. Giacomazi, and C. Zenantoni (European Atomic Energy Community) p 87–99 (See N67-18231 08-22)

11. NUCLEAR SHIELDING AND RESULTING ASPECTS FOR OVERALL CONSTRUCTION OF TRIKT 50 G. Hehn (Technische Hochschule Stuttgart) p 101–110 refs (See N67-18232 08-22)

N67-18223# Technische Hochschule Stuttgart (West Germany).
DESIGN STUDY OF NUCLEAR THERMIONIC REACTOR FOR ENERGY POWER PLANT OF SPACE FLIGHT EQUIPMENT [ENTWURFSSTUDIE EINER ENERGIEVERSORGUNGSANLAGE FUR RAUMFLUGGERATE MIT EINEM THERMISCHEN KERNREAKTOR (TRIKT-50)]
W. Haug, R. Fritz, R. Pruschek, and E. Wolf *In* WGLR Rept. on the Meeting of the WGLR Comm. on Nucl. Energy in Aerotechnol., 8–9 Dec. in Stuttgart Jun. 1966 p 9 ref In GERMAN (See N67-18221 08-22) CFSTI: HC $3.00/MF $0.65

Projected is a specific mass estimate for the nuclear thermionic reactor TRIKT-50 to be used as energy generator for space vehicles. This power plant has a capacity of about 50 kW output and utilizes a thermionic converter to change nuclear thermal energy into electric energy. A detailed description of the thermionic converter together with the specific mass values of its different components is given in the journal "Atomic Nuclear Energy", 1956, volume 9/10. Transl. by G.G.

N67-18224# Internationale Atomreaktorbau Gesellschaft, Bensberg (West Germany).
METAL HYDRIDE MODERATED REACTOR SYSTEMS AS ENERGY SOURCE FOR SPACE VEHICLES [METALLHYDRID-MODERIERTE REAKTORSYSTEME ZUR ENERGIEVERSORGUNG VON RAUMFLUGKORPERN]
K. Einfeld *In* WGLR Rept. on the Meeting of the WGLR Comm. on Nucl. Energy in Aerotechnol., 8–9 Dec. in Stuttgart Jun. 1966 p 11–27 refs In GERMAN (See N67-18221 08-22 CFSTI: HC $3.00/MF $0.65

Discussed are reactor systems that employ metal hydride moderators to provide spacecraft power. Thermionic–electric conversion systems are found generally suitable for an output below 100 kW. Evaluation of zirconium hydride, yttrium hydride, and beryllium hydride moderated reactor systems show that the yttrium moderator was preferable for reaction temperatures of up to 700° C because of its lighter weight; however, at required reaction temperatures of 850°C, the zirconium and beryllium hydride moderated systems are more advantageous. Transl. by G.G.

N67-18225# Max-Planck-Institut fur Metallforschung, Stuttgart (West Germany). Institut fur Sondermetalle.
TRANSITION METAL HYDRIDE COMPOUNDS AS MODERATOR MATERIALS [MODERATORMATERIALIEN AUF DER BASIS WASSERSTOFFHALTIGER UBERGANGS-METALLVERBINDUNGEN]
H. Goretzki *In* WGLR Rept. on the Meeting of the WGLR Comm. on Nucl. Energy in Aerotechnol. 8–9 Dec. in Stuttgart Jun. 1966 p 29–30 In GERMAN (See N67-18221 08-22) CFSTI: HC $3.00/MF $0.65

Various thermal stable hydrides of transition metals were evaluated for their neutron thermalization properties in middle-range electric space power plants. Metals with minimal thermal neutron absorption were YH_2, CeH_2, and ZrH_2; CeH_2 possessed a hydride density of 4.6×10^{-22} H-atoms/cm^3. Ternary phases of the transition metals reached a maximal hydrogen density of 4.5×10^{-22} H-atoms/cm^3. Transl. by G.G.

N67-18226# Brown, Boveri und Cie, A. G., Mannheim (West Germany).
DEVELOPMENT OF NUCLEAR HEATED THERMIONIC ENERGY CONVERTER [ENTWICKLUNG EINES NUKLEAR BEHEIZTEN THERMIONISCHEN ENERGIEWANDLERS]
F. Gross, A Jester, and H. Winkenbach *In* WGLR Rept. on the Meeting of the WGLR Comm. on Nucl. Energy in Aerotechnol. 8–9 Dec. in Stuttgart Jun. 1966 p 31–47 In GERMAN (See N67-18221 08-22) CFSTI: HC $3.00/MF $0.65

Development work for an inpile nuclear thermionic energy converter centered on the construction of a cesium diode with cylindrical molybdenum emitter and a niobium collector for use as reactor fuel element. Also reported were irradiation studies on a molybdenum emitter filled with uranium dioxide powder. Observed were changes in emitter filled with uranium dioxide powder. Observed were changes in emitter shape, fuel diffusion and nuclear particles, as well as the effects of different fuel consistencies on its performance. Transl. by G.G.

N67-18227# Brown, Boveri und Cie, A. G., Heidelberg (West Germany).
A NEW THERMIONIC REACTOR CONCEPT
N. Rasor *In* WGLR Rept. on the Meeting of the WGLR Comm. on Nucl. Energy in Aerotechnol., 8–9 Dec. In Stuttgart Jun. 1966 p 48 (See N67-18221 08-22) CFSTI: HC $3.00/MF $0.65

A new thermionic reactor concept is described, and its performance and weight estimated. The design and estimates are based on thermionic converter and reactor systems which have been tested seperately for lifetimes approaching a year. Simplicity and reliability are emphasized. Difficulties with high temperature electrical insulation, chemical compatibility are avoided by physically separating the converters from the fuel. The system has no major moving parts of fluids, and occupies only 1/8 m^3 of space, including radiator. Specific weights in the vicinity of 50 kg/kW$_e$ for a 10 kW$_e$ system appear to be attainable using demonstrated technology. Author

N67-18228# Battelle Inst., Frankfurt am Main (West Germany).
EMITTER CONTAINING CARBIDE FUEL FOR THERMIONIC CONVERTERS [EMITTER MIT CARBIDISCHEM BRENNSTOFF FUR THERMIONISCHE KONVERTER]
R. Gunther, M. Kadner, E. Poeschel, H. Rochow, and K. Schuster *In* WGLR Rept. on the Meeting of the WGLR Comm. on Nucl. Energy in Aerotechnol., 8–9 Dec. in Stuttgart Jun. 1966 p 49–67 refs In GERMAN (See N67-18221 08-22) CFSTI: HC $3.00/MF $0.65

Discussed was the construction of an optimal thermionic cesium diode for reactor fuel element. Parametric studies on close-spaced cesium thermionic converters found that electrical currents of more than 40 W/cm^2 emitter surface were only obtainable when the distance between emitter and collector was extremely close. Evaluation of other emitter materials showed that tungsten and rhenium emitters were superior energy converters; addition of fluor increased ionization properties of all emitters and doubled the output of rhenium emitters working at 1800° temperature. The use of carbon coated uranium particles was recommended as nuclear fuel for cesium diodes. Transl. by G.G.

N67-18229# Battelle Inst., Frankfurt am Main (West Germany).
HIGH TEMPERATURE TESTS ON TUNGSTEN COATED URANIUM DIOXIDE-MOLYBDENUM-CERMETS FOR THERMIONIC REACTOR FUEL ELEMENTS [HOCHTEMPERATURTESTS AN MIT WOLFRAM UMHULLTEN UO_2-MO-CERMETS FUR THERMIONISCHE REAKTORBRENNELEMENTE]
K. Schuster *In* WGLR Rept. on the Meeting of WGLR Comm. on Nucl. Energy in Aerotechnol., 8–9 Dec. in Stuttgart Jun. 1966 p 69–71 In GERMAN (See N67-18221 08-22) CFSTI: HC $3.00/MF $0.65

Property changes of tungsten coated UO_2-fuelled–Mo-cermets for thermionic emitters were studied after several hours' exposure to 1800°C. Surface microscopy, shape changes, evaporation, alpha activity, and electron microscopic studies of treated samples established the following structural changes: the matrix molybdenum diffused very quickly into the outer tungsten layer; increased heating time increased also the surface crystallization; only uranium dioxide vapor evaporated from heated samples; and the outer tungsten layer was not able to prevent uranium dioxide vaporization. Transl. by G.G.

N67-18230# Entwicklungspring Nord, Bremen (West Germany).
RADIO NUCLIDES FOR ENERGY SUPPLY [ENERGIEVERSORGUNG DURCH RADIONUKLIDE]
D. Hannemann *In* WGLR Rept. on the Meeting of the WGLR Comm. on Nucl. Energy in Aerotechnol., 8–9 Dec. in Stuttgart Jun. 1966 p 73–82 refs In GERMAN (See N67-18221 08-22) CFSTI: HC $3.00/MF $0.65

Described were design and working characteristics of an isotopic battery that converted the nuclear energy emitted during strontium oxide decay into yttrium 90 and zirconium 90 into electric power. A battery with 125 inserted strontium isotope rods of 5 mm diameter obtained an output of 766 thermal W, weighted 950 g, and showed a β-activity of 230 kc. Transl. by G.G.

N67-18231# European Atomic Energy Community, Ispra (Italy).
AN EVALUATION OF FAST REACTOR POWER PLANTS FOR SPACE APPLICATIONS
W. Balz, G. Giacomazi, and C. Zanantoni *In* WGLR Rept. on the Meeting of the WGLR Comm. on Nucl. Energy in Aerotechnol., 8–9 Dec. in Stuttgart Jun. 1966 p 87–99 (See N67-18221 08-22) CFSTI: HC $3.00/MF $0.65

This preliminary conceptual study on fast reactor plants for space power sources considered the dynamics of liquid metal vaporization to run a turbine driven alternator. Plants studied were optimized for various boiling temperatures and best radiating temperatures to get a weight ratio near the minimum allowance. Comparison of a direct Hg cycle and an indirect lithium–potassium cycle showed that their respective weights would be the same but that the Hg plant uses much lower temperatures for cooling, turbine inlet, and pumps; it was concluded that a direct Hg cycle fast reactor is most promising for space applications. G.G.

N67-18232# Technische Hochschule Stuttgart (West Germany). Institut für Kernenergetik.
NUCLEAR SHIELDING AND RESULTING ASPECTS FOR OVERALL CONSTRUCTION OF TRIKT 50 [NUKLEARE ABSCHIRMUNG UND DARAUS RESULTIERENDE GESICHTSPUNKTE FUR DIE GESAMTANLAGE DES TRIKT 50]
G. Hahn *In* WGLR Rept. on the Meeting of the WGLR Comm. on Nucl. Energy in Aerotechnol. 8–9 Dec. in Stuttgart Jun. 1966 p 101–110 refs In GERMAN (See N67-18221 08-22) CFSTI: HC $3.00/MF $0.65

Considered were the various problems of reactor shielding and its weight optimization for the construction of an inpile nuclear thermionic space power plant. As best neutron shield evolved a layer of 7LiH on LiH, or a boron graphite layer followed by a layer of metal foil and lithium hydride. Evaluation of the cooling elements ^{23}Na, ^{41}K, ^{7}Li, and ^{16}O at a gamma radiation dose of 10^{7} R over a one year period showed that sodium was generally sufficient for cooling purposes; the use of ^{7}Li reduced the radiative factor of the cooling medium about 200. Transl. by G.G.

N67-18387# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.
BURNUP DETERMINATION OF NUCLEAR FUELS
In its Div. Anal. Branch for 1965 Jun. 1966 p 43–46 refs Submitted for publication (See N67-18381 08-06)

The development of methods for accurate determination of the burnup of nuclear fuel is considered. The measurement of U^{235} thermal fission yields for many stable and long-lived fission products is reported, and tentative fission yield values are presented in tabular form. Separation methods developed for alkali metals, alkaline earths, and ruthenium applicable to irradiated uranium and plutonium samples are mentioned. Tentative results from the measurement of U^{233} thermal fission yields are tabulated, and additional measurements of U^{235} and U^{233} thermal fission yields from the second irradiated capsules of U^{235} and U^{233} are also reported and the results tabulated. Brief consideration is also given to the development of an isotope dilution, a mass spectrometric analysis method for ruthenium, and the determination of the absolute thermal fission yields of stable and long-lived isotopes of ruthenium for U^{233} and U^{235}. L.E.W.

N67-18475# Oak Ridge National Lab., Tenn.
CHEMICAL TECHNOLOGY DIVISION Annual Progress Report, Period Ending 31 May 1966
Sep. 1966 287 p refs
(Contract W-7405-ENG-26)
(ORNL-3945) CFSTI: HC $3.00/MF $0.65

Papers are presented on various aspects of reactor chemistry, technology, and processing. Among the areas covered are: chemistry of individual elements and compounds; high temperature chemistry, and chemical applications of nuclear explosions; biochemical separations, mechanisms of separations, and fission product recovery by solvent extractions; thorium and uranium fuel cycle processing, fluoride volatility processing, and molten salt reactor processing; waste treatment and disposal, water research, and industrial applications of nuclear energy. Abstracts are included for most of the articles. N.E.N.

N67-18478# General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.
HIGH POWER DENSITY DEVELOPMENT PROJECT Quarterly Progress Report, Dec. 1965–May 1966
C. L. Howard and R. N. Duncan, comp. Jun. 1966 24 p refs
(Contract AT(04-3)-361)
(GEAP-5126; QPR-23/24) CFSTI: HC $3.00/MF $0.65

Twenty-two developmental fuel assemblies accumulated exposure as part of an 84-bundle core in the Consumers Big Rock Point reactor until a scheduled shutdown on April 8, 1966. During the April 1966 reactor shutdown, several of the developmental assemblies were visually inspected. Selected fuel rods were removed from these assemblies, dimensional profiles were obtained, and the fuel rods were reinserted for continued irradiation. Two of the eight Group I developmental assemblies, PE-3 and PO-2, were part of this core loading, and were suspected of containing failed fuel rods. Visual inspection of the PE-3 assembly indicated that at least five fuel rod failures had occurred. Two peripheral fuel rods and three interior fuel rods were verified as being failed. Visual inspection of the PO-2 assembly revealed a minor suspect region on one fuel rod. Penetration of the cladding at this one area could not be verified by the visual examination. Visual inspection of other developmental assemblies containing fuel rods with Zircaloy-2, Incoloy-800, and Inconel-600, and fabricated by various processes, revealed no failed fuel rods. Nonuniform crud deposition was observed on all peripheral fuel rods. Variations in the appearance of the crud deposits were observed both along the length of the fuel rods and around the circumference. Dimensional profiles were obtained on fuel rods removed from the above assemblies and then reinserted into the assemblies for continued irradiation. Increases in the diameter and ovality of fuel rods were measured. Analysis of these data indicates that the fuel rod diameter increases and ovality are due to nonuniform adherent crud deposition. Cladding deformation may have occurred but cannot be measured due to the adherent crud deposits on most of the fuel rod surfaces. Author (NSA)

N67-18480# General Dynamics Corp., San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science.
HIGH-TEMPERATURE GAS-COOLED ADVANCED CONVERTER REACTORS AND THE COLORADO PROJECT
S. Jaye, C. L. Rickard, and H. B. Stewart 16 May 1966 37 p Presented at the Symp. on High-Temp. Gas-Cooled Reactors and the Dragon Reactor Expt., London, 23–24 May 1966
(Contracts AT(04-3)-633; AT(04-3)-167)
(GA-7149; CONF-660554-1) CFSTI: HC $3.00/MF $0.65

The design objectives and anticipated fuel cycle performance characteristics of commercial HTGR power plants in the 660 MW(e) and 1000 MW(e) sizes are discussed. Design considerations that have evolved in the 330 MW(e) prototype being developed for the Public Service Company of Colorado are also described. NSA

N67-18501# Battelle-Northwest, Richland, Wash. Physics and Instruments Dept.
PHYSICS RESEARCH Quarterly Report, Jan.–Mar. 1966

15 Apr. 1966 32 p refs
(Contract AT(45-1)-1830)
(BNWL-284) CFSTI: HC $3.00/MF $0.65

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N67-18503# Battelle-Northwest, Richland, Wash. Light Moderator Reactor Physics Unit.

SENSITIVITY OF THERMAL REACTOR PARAMETERS TO SCATTERING MODEL

J. R. Worden, W. L. Purcell, and R. C. Liikala *In its* Phys. Res. 15 Apr. 1966 p 3–5 refs (See N67-18501 08-22) CFSTI: HC $3.00/MF $0.65

Summary data are presented on comparative studies conducted to determine the effect of the choice of scattering model for the common moderating materials, H_2O, D_2O, and graphite, on calculated reactor parameters. Tabulated data are presented on the values of $\bar{\eta}$ and f for both air cooled and H_2O cooled uranium fueled graphite lattices, and for 8 in. D_2O lattices fueled with natural UO_2, 19-rod clusters. Results indicate that the Nelkin scattering model is adequate for H_2O; however, it is tentatively concluded that the models considered for scattering in D_2O need improvement. M.G.J.

N67-18504# Battelle-Northwest, Richland, Wash. Light Moderator Reactor Physics Unit.

COMPUTER ANALYSIS OF REACTOR NOISE DATA

L. C. Schmid and G. D. Seybold *In its* Phys. Res. 15 Apr. 1966 p 6–10 refs (See N67-18501 08-22) CFSTI: HC $3.00/MF $0.65

In the analysis, the amplitude data of the reactor noise frequency spectrum is put in a form amenable to comparison with the theoretical function. Parameters are then obtained from the experimental data by fitting the theoretical functions to the data using improved least squares fitting techniques. The necessary equations are derived. For the computer analysis, the Noise program, written for the Univac 1107, uses a generalized input routine to reduce input data requirements. In addition to the parameters (and their errors) which result in the best fit to the data, the output consists of data points and the fitted curve plotted in decibels on semilog paper. M.G.J.

N67-18505# Battelle-Northwest, Richland, Wash. Light Moderator Reactor Physics Unit.

SENSITIVITY OF REACTOR MULTIPLICATION VALUES TO CROSS SECTION UNCERTAINTIES FOR THERMAL SYSTEMS

R. C. Liikala, W. L. Purcell, and J. R. Worden *In its* Phys. Res. 15 Apr. 1966 p 11–12 refs (See N67-18501 08-22) CFSTI: HC $3.00/MF $0.65

A brief review is presented on studies conducted to determine the extent to which the theoretical prediction of reactor multiplications, k_{eff}, is influenced by the uncertainty in the nuclear data involved. Attention was focused on nuclear data σ_a and $\nu\sigma_f$ for the fissile and fertile isotopes of the reactor systems analyzed. Among the results reported are: (1) The k_{eff} for all systems considered is most sensitive to changes in the thermal cross section of the principal fissile nuclide in the fuel. (2) For any of the fission nuclides, the multiplication is more sensitive to a change in the product $\bar{\nu}\sigma_f$ thermal than to the same percentage change in $\bar{\sigma}_a$ thermal. (3) The maximum uncertainty in k_{eff} due to uncertainties in resonance and thermal cross section data are respectively 1% (10 mk) and 0.5% (5 mk). M.G.J.

N67-18506# Battelle-Northwest, Richland, Wash. Light Moderator Reactor Physics Unit.

LUTETIUM ACTIVATIONS AND SPECTRAL INDICES IN A D_2O-MODERATED REACTOR WITH Pu–Al 19-ROD CLUSTERS

V. O. Uotinen *In its* Phys. Res. 15 Apr. 1966 p 13–19 refs (See N67-18501 08-22) CFSTI: HC $3.00/MF $0.65

Details are given on an experiment conducted in the plutonium recycle critical facility (PRCF) to measure the energy and spatial distribution of neutrons in a cell consisting of a Pu–Al 19-rod cluster moderated with D_2O. Also measured were the spectral indices T and r, which characterize the thermal component and the epithermal component of the neutron spectrum. These were deduced from gamma ray activities of lutetium foils activated at 10 radial positions in the reactor. The spectral induces were compared with similar measurements made in the plutonium recycle test reactor (PRTR). Spatial variations of lutetium activity and thermal flux were compared with calculations obtained with the transport theory code, Thermos. Results show that the spectral indices in the cluster, based on the PRTR and PRCF data, agree within their errors. However, the value of T deduced from the PRTR moderator is larger than the T values in the cluster which casts some doubt on the validity of T for the moderator. The PRCF results appear reasonable. Calculations based on the Thermos computer code were found to overestimate the thermal flux depression in the fuel. M.G.J.

N67-18507# Battelle-Northwest, Richland, Wash. Light Moderator Reactor Physics Unit.

REACTIVITY WORTH OF NEUTRON ABSORBING RODS IN PLUTONIUM-FUELED, H_2O-MODERATED SYSTEMS

V. O. Uotinen and R. C. Liikala *In its* Phys. Res. 15 Apr. 1966 p 20–21 refs (See N67-18501 08-22) CFSTI: HC $3.00/MF $0.65

Experimental details are briefly summarized, and some data on the measurement results are reported. A table is included to show the worth for removal of neutron absorbing rods relative to H_2O in various plutonium fueled, H_2O moderated systems. The ratio of subcadmium worth to epicadmium worth is between 3 and 4 for the HfO_2 rods, and $\approx$10 for the boron rods. The worth as a function of Pu^{240} concentration in the fuel is depicted for a moderator to oxide volume ratio of 3.469. M.G.J.

N67-18529# Oak Ridge National Lab., Tenn.

OPERATING SAFETY LIMITS FOR THE HIGH FLUX ISOTOPE REACTOR (HFIR) (100 Mw MAXIMUM POWER)

16 Sep. 1966 11 p
(Contract W-7405-ENG-26)
(ORNL-TM-1532, Rev.) CFSTI: HC $3.00/MF $0.65

Limits for operating variables which have a direct reactor safety significance are established. Each limit designates a realistic boundary to the operating range of the variable. NSA

N67-18534# Atomics International, Canoga Park, Calif.
DEVELOPMENTAL IRRADIATION TEST OF SNAP-8 ELECTRICAL COMPONENTS (HF-8)
N. F. Davies 15 Jul. 1966 23 p
(Contract AT(11-1)-GEN-8)
(NAA-SR-11924) CFSTI: HC $3.00/MF $0.65

Results of irradiation tests to determine the effects of the SNAP operating environment on the performance of connectors, cables, and electric insulation specimens for use in the SNAP 8 reactor are presented. Results indicate that with proper cleanliness standards and vacuum conditions, most inorganic insulation systems are not severely affected by high-temperature, radiation, and vacuum environments. The suitability of electrical components for use in the S8DS reactor system was proved. NSA

N67-18583# General Electric Co., Pleasanton, Calif.
DIFFUSION OF PLUTONIUM AND URANIUM IN OXIDE FUEL AT 2400°C
J. H. Davies and P. E. Novak Mar. 1966 23 p refs
(Contract AT(04-3)-189)
(GEAP-4877) CFSTI: HC $3.00/MF $0.65

The self-diffusion coefficients of U and Pu were measured in $UO_{2.03}$ at 2400°C to be $D_U = 2.6 \times 10^{-10}$ cm²/sec, and $D_{Pu} = 3.4 \times 10^{-10}$ cm²/sec. Quantitative correlation of these measurements with the lower temperature (1300 to 1705°C) work of others must be speculative because of the possible differences in the dominant diffusion processes operative at the widely differing temperatures of the several investigations. However, these observed diffusion coefficients are well within the limits of uncertainty expected in the extrapolation of lower temperature values. Author (NSA)

N67-18584# Iowa State Univ. of Science and Technology, Ames.
IN-PLACE TESTING OF CHARCOAL FILTER BANKS AT AMES LABORATORY RESEARCH REACTOR (ALRR)
C. A. Gukeisen and K. L. Malaby Sep. 1966 13 p refs
(Contract W-7405-ENG-82)
(IS-1425) CFSTI: HC $3.00/MF $0.65

The air exhaust system at the ALRR is described. An experimental program was conducted to develop an appropriate in-place iodine test for the charcoal filter banks. Three techniques were tested: spectrophotometric analysis, neutron activation, and ^{131}I tracer. Comparisons of the testing results and experience are enumerated with comments and recommendations. The neutron activation and the ^{131}I tracer techniques proved to be the most appropriate methods for in-place testing of the ALRR charcoal filter banks. Author (NSA)

N67-18588# Los Alamos Scientific Lab., N. Mex.
THE IRRADIATION OF LIQUID PLUTONIUM FUELS IN A THERMAL REACTOR
Richard L. Cubitt, George L. Ragan, and Donald C. Kirkpatrick Apr. 1966 30 p refs
(Contract W-7405-ENG-36)
(LA-3557) CFSTI: HC $3.00/MF $0.65

In-pile test loops for irradiating liquid Pu fuel alloys were designed and operated in the Omega West Reactor. These loops provide a Na environment for test fuel capsules at temperatures corresponding to those expected for LMBFR. Seven fuel capsules were irradiated with up to 2% burnup of Pu. Irradiation of two fuel specimens is currently in progress. The design, construction, and operation of the irradiation loops are described along with handling of the irradiated test fuel capsules. Author (NSA)

N67-18589# General Electric Co., San Jose, Calif. Vallecitos Atomic Lab.
HIGH-TEMPERATURE WATER SOLIDS CONCENTRATOR
M. D. Fitzsimmons Feb. 1966 16 p
(Contract AT(04-3)-189)
(GEAP-5122) CFSTI: HC $3.00/MF $0.65

A description is given of the physical arrangement and operation of a device which extracts nonvolatile substances from a water sample by evaporation. The process is unique in that the evaporation is performed at system pressure and the corresponding saturation temperature without cooling of the sample between the source and the sample processing device. Author (NSA)

N67-18591# Battelle-Northwest, Richland, Wash.
THE IRRADIATION BEHAVIOR OF UO_2–PuO_2 FUELS IN PATR
M. D. Freshley, F. E. Panisko, and R. E. Skavdahl 22 Jul. 1966 29 p refs Presented at the 1966 AIME Nuclear Metal. Symp. on High Temp. Nucl. Fuels, Delaware, Wis., 3–5 Oct. 1966
(Contract AT(45-1)-1830)
(BNWL-SA-791; CONF-661003-4) CFSTI: HC $3.00/MF $0.65

Vibrationally compacted UO_2–PuO_2 fuel structures change dramatically under the irradiation conditions expected during the Batch Core Experiment, i.e., maximum rod powers of 20 kw/ft with centerline fuel temperatures near melting. Under molten core conditions, the physical behavior of vibrationally compacted fuel varies noticeably, even in like rods exposed to nominally the same conditions. Melting in vibrationally compacted UO_2–2 wt % PuO_2 fuel commences at a linear rod power of 20–21 kw/ft. Melting is evidenced by the formation, on cooling, of a well-defined cellular structure in the thermal center of the fuel rod. Melting usually results in axial fuel relocation. Although the defect behavior of vibrationally compacted UO_2–PuO_2 fuel rods has been excellent at lower power generations (i.e., up to ≈24 kw/ft), a "rupture threshold" may have been experienced at high power generations (in the neighborhood of 27 kw/ft). Behavioral differences in such phenomena as fuel oxidation have been indicated between non-defected and defected UO_2–PuO_2 fuel rods. Fission gas release values as high as 88% have been measured in vibrationally compacted UO_2–PuO_2 fuel rods that were operated with volumetric average fuel temperatures of approximately 2200°C. Author (NSA)

N67-18596# Keuring van Electrotechnische Materialen, N. V., Arnhem (Netherlands).
INVESTIGATIONS OF FINE FUEL IN AUTOCLAVES. PART I: THORIUM OXIDE
H. J. C. Boekschoten 5 May 1966 34 p refs
(NP-16348, Pt. 1; CH-E/INT.R.-38/66)

Studies were made of the flow properties, sedimentation, and caking of ThO_2 suspensions for the Kema Suspension Test Reactor. The following conclusions were made; agglomeration is important in the range between low and high shear stresses; soft cake is formed at low temperatures and high concentrations and depends on the kind of suspension, but is nearly absent in acid medium. NSA

N67-18601# Laboratoires du Centre d'Etude de l'Energie Nucleaire, Mol (Belgium).
IN-PILE CORROSION OF NUCLEAR MATERIALS Quarterly Report No. 4, Dec. 1, 1965–Feb. 28, 1966
28 Feb. 1966 19 p
(Contract EURATOM-055-65-3 TEEB (RD))
(EURAEC-1702; EUR-2888; R-2388) CFSTI: HC $3.00/MF $0.65

In order to determine the effects of radiolysis of water on the electrochemical potential of steel and Pt, the potential changes of these metals have been measured in solutions containing ferrous and ceric ions. It has been found that the potential of Pt in a solution of Fe^{3+} and Ce^{4+}/Ce^{3+} by gamma irradiation may show a drop of about 700 mV indicating reduction of the ceric ions. Steel in the same solution sometimes also indicates a

potential decrease by gamma irradiation of the solutions. However, the results are obscured by the ability of steel to reduce excess ceric ions. A potential rise in solutions of Ce^{3+}+Fe^{3+}/Fe^{2+} has not been found during the applied irradiation times (65 hours at 1.68×10^5 RAD/hr). Addition of an organic impurity to the water (ethyl alcohol) further decreases the electrochemical potential of Pt. The Pt potential in that case corresponded to that of the hydrogen electrode. It was again not definite whether alcohol addition affected the potential of steel. The potential drops observed were less pronounced than in the case of Pt. Analysis of the solution and the oxide on 18/8 stainless steel and the H_2SO_4 solution used for coulometric reduction of the oxide has shown that chromium oxide may dissolve. Potential-time curves measured during reduction of oxide films on pure chromium showed two distinctive steps in the reduction process. Author (NSA)

N67-18602# Bettis Atomic Power Lab., Pittsburgh, Pa.
A COMPILATION OF THE PROPERTIES OF HAFNIUM
C. V. Taylor and J. G. Goodwin Aug. 1966 25 p refs
(Contract AT(11-1)-GEN-14)
(WAPD-TM-528) CFSTI: HC $3.00/MF $0.65

Data on the physical, mechanical, and corrosion properties of Hf are compiled from current literature. Some data on the effects of irradiation on the properties of a Hf control rod after various stages of exposure are included. Most of the information is presented in the form of graphs. NSA

N67-18614# Oak Ridge National Lab., Tenn.
CALCULATION OF THE THERMAL NEUTRON FLUX AND CURRENTS, ENERGY, AND GAMMA DOSE ON THE AXIS OF A CHANNEL OF A GRAPHITE-CO_2 REACTOR: DOMINO 2 PROGRAM FOR THE IBM 7094
Jacques Duco [1966] 64 p refs Transl. into ENGLISH of the Rept. CEA-N-591 by Commissariat a l'Energie Atomique
(ORNL-TR-1374) CFSTI: HC $3.00/MF $0.65

The DOMINO 2 program for the evaluation of fluxes and currents from sources on the walls on the axis of cylindrical pipes with varying radius and thickness is described. The program is used to calculate the fluxes and currents of thermal neutrons and the energy and gamma dose on the axis of an empty channel in the axial upper shield of the EDF2 reactor. NSA

N67-18615# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik.
DETERMINATION OF THE NEUTRONIC VALUES OF SODIUM-COOLED FAST REACTORS WITH THE SNEAK-2 ASSEMBLY
R. Durand-Smet [1965] 52 p refs Transl. into ENGLISH from German
(EURFNR-76F; KFK-382) CFSTI: HC $3.00/MF $0.65

The theoretical and practical problems which arise in the simulation of large fast breeder reactors are described. The technique of two-zoned assemblies, effects of material inhomogeneity, methods of calculation, and the possibility of simulating reactor material by a mixture of two cheap materials are investigated. The SNEAK-2 assembly is described and its neutronic properties (criticality factor, extrapolated dimensions, reactivity worth of materials at the center of the assembly) are indicated. The Na-reactivity coefficient is investigated, and the local danger coefficient, the void-coefficient, and the density-coefficient of Na in the core are defined and calculated. A one-dimensional diffusion program, a 16-group set, and a 26-group set were used to calculate these neutronic values in spherical or cylindrical geometry. NSA

N67-18616# United Kingdom Atomic Energy Authority, Harwell (England).
BORON PILE r MEASUREMENTS
D. W. Colvin and M. G. Sowerby Feb. 1965 43 p refs
(EANDC(UK)-52-S; SM-60/44)

Results are presented from an experiment designed to measure the average number of neutrons per fission (ν) accurately and absolutely without the use of a standard source. NSA

N67-18641# Los Alamos Scientific Lab., N. Mex.
GENERATION OF THERMIONIC ELECTRICITY FROM THE THERMAL ENERGY FROM NUCLEAR COMBUSTION
Melvin F. Sankevich and Paul F. Schutt [1966] 16 p Transl. into ENGLISH of French Patent no. 1336354
(LA-TR-66-32)

This invention includes a cell adapted to the thermionic generation of electricity from thermal energy from a nuclear fuel irradiated by neutrons. The cell contains a pair of thermionic conversion elements involving cathodes on the respective faces of a mass of nuclear fuel and a thermal exchange relationship with the latter. There are associated anodes adapted for liquid cooling with arrangements for receiving the electrons emitted thermionically by the corresponding cathodes. NSA

N67-18647# Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.
PERFORMANCE CHARACTERISTICS OF A LARGE FAST BREEDER REACTOR CORE WITH BUNDLE CONTROLLED EXPANSION (BCEX) FUEL ASSEMBLIES
May 1966 474 p refs
(Contract AT(30-1)-3589)
(WCAP-3589-2) CFSTI: HC $3.00/MF $0.65

Included are the identification of the problem areas, and the analyses and evaluation of the performance characteristics of the Bundle Controlled Expansion (BCEX) concept in the Westinghouse Large Fast Breeder Reactor using a modular, carbide-fueled core. The dynamic behavior of a second concept, fuel rod Clad Controlled Expansion (CCEX) was also studied briefly in the carbide-fueled modular core. The dynamic performance of the BCEX and CCEX concepts were also briefly investigated in a gas bonded, oxide-fueled core. The results of all the transient analyses performed in this investigation demonstrated that utilization of either of the axial thermal expansion concepts, CCEX or BCEX, significantly improved the core transient behavior over that of the non-CEX (zero thermal expansion) core. Both BCEX and CCEX can potentially provide ceramic-fueled fast reactor cores with a predictable, negative, axial expansion, reactivity feedback mechanism that will contribute significantly in terminating a power excursion by supplementing the Doppler coefficient. Author (NSA)

N67-18720 European Atomic Energy Community, Ispra (Italy). Reactor Physics Dept.
STUDIES OF ^{240}Pu RESONANCE ABSORPTION IN HETEROGENEOUS SYSTEMS
F. Beonio-Brocchieri and E. Diana Oct. 1966 24 p refs
(EUR-3151.e) CFSTI: $3.00

Usual methods for determining the effective resonance integral of the most common fertile materials introduce some important approximations. In order to investigate how the large practical width of the ^{240}Pu resonance at 1.05 eV may invalidate these approximations a basic study has been performed by comparing, for different heterogeneous systems, the results obtained with sophisticated methods to the results given by the more usual ones (Nordheim, Chernick and Vernon, Cohen and Goldstein). The same calculation methods have been tested against the experimental values measured by Nichols at Hanford. Author

N67-18780# Atomics International, Canoga Park, Calif.
EFFECTIVE GROUP ABSORPTION CROSS-SECTIONS AND RESONANCE OVERLAP

F. L. Fillmore 15 Jul. 1966 46 p refs
(Contract AT(11-1)-GEN-8)
(NAA-SR-11963) CFSTI: HC $3.00/MF $0.65

The effect of resonance overlap on multigroup resonance cross sections and the Doppler coefficient is examined. Consistent definitions are given for the group flux and effective cross section using both the TRUE FLUX and the 1/E FLUX methods. Approximate expressions are developed for the effective resonance absorption cross section in a homogeneous mixture. The validity of the approximations is discussed for typical fast reactor cores, and an example is presented of a correction for self-overlap. The calculation of reactivity coefficients by means of first-order perturbation theory is interpreted, and it is shown that the same result is obtained with either the TRUE FLUX or the 1/E FLUX method of defining the effective cross sections; however, the TRUE FLUX method is the one recommended. Approximate expressions for the change in the effective absorption cross section due to Doppler broadening of resonances are developed, and consideration is given to the effect of resonance overlap on this change in the effective cross section. It is concluded that the error in the Doppler coefficient for typical fast reactor cores due to neglecting resonance overlap should usually not exceed a few percent provided that the TRUE FLUX definitions are used for the effective cross sections. It is recognized, however, that situations may exist where the neglect of resonance overlap is not justified. Author (NSA)

N67-18781# Atomic Energy Commission, Washington, D. C. Div. of Technical Information.
NEUTRON CROSS SECTION TECHNOLOGY
P. B. Hemmig 24 Mar. 1966 562 p refs Proc. held in Washington, D. C., 22–24 Mar. 1966; Sponsored by AEC, Am. Phys. Soc., NBS, and Am Nucl. Soc.
(CONF-660303, Bk. 1) CFSTI: HC $3.00/MF $0.65

In the conference papers presented, attention was focused on the cross section needs, measurements, and critique in the neutron energy range 0 to 100 eV, from 100 eV to 100 keV, and above 100 keV; methods of calculating, evaluating, and compiling cross section data; and special problems in the measurement and utilization of fission cross sections. For individual abstracts see N67-18782 through N67-18820.

N67-18782# Brookhaven National Lab., Upton, N. Y.
THE SENSITIVITY OF REACTOR CHARACTERISTICS TO CROSS SECTION UNCERTAINTIES BELOW 100 eV
R. L. Hellens *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 3–30 refs Sponsored by AEC (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

The development of accurate computational methods for thermal reactor lattices has reached the point at which neutron cross section uncertainties are a major limitation to the confidence with which theory can be applied to practical situations. This sensitivity to nuclear data is readily seen in the analysis of extremely simple lattice experiments, although it is still present, of course, in calculations for power reactors of greater geometrical complexity where errors in describing spatial effects may effectively hide basic discrepancies. In this paper, the basic lattice data and computational methods are briefly reviewed, and the connection between uncertainties in cross sections and in predicted reactor characteristics is traced for some typical reactor lattices. The effect during reactor life of changes in the cross sections assigned to both fertile and fissile isotopes in the uranium and plutonium chains is described for some light and heavy water moderated reactors. Author (NSA)

N67-18783# Oak Ridge National Lab., Tenn.
MEASUREMENTS OF LOW ENERGY NEUTRON CROSS SECTIONS OF NON-FISSILE NUCLIDES AND THEIR INTERPRETATION
J. A. Harvey *In* AEC Neutron Cross Sec. Technol. 24 Mar. 1966 p 31–54 refs Sponsored by AEC (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

Transmission, capture, and scattering measurements can be made with high resolution and accuracy up to 100 eV upon any nonfissile stable nuclide if a suitable sample (≈grams) is available. These measurements can be analyzed by the shape or area method to give accurate parameters for all but the very small resonances. Measurements upon small samples (≈mgms) with low isotopic enrichment or which are highly radioactive can give accurate parameters up to ≈10 eV and for the strong resonances up to ≈100 eV. Cross section measurements and resonance analysis for several nuclides which are or have been of interest in the design of thermal and intermediate energy reactors are described. Author (NSA)

N67-18784# General Dynamics Corp., San Diego, Calif. General Atomic Div.
ACCURACY OF RESONANCE PARAMETERS FROM COMBINED AREA AND SELF-INDICATION MEASUREMENTS
F. H. Froehner, E. Haddad, W. M. Lopez, and S. J. Friesenhahn *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 55–66 refs (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65
(Contract AT(04-3)-167)

The information which can be obtained from measured transmission areas, capture areas, scattering areas, and self-indication ratios is studied by means of the analysis curves (Γ_n versus Γ_γ). It is shown that the character of the curve intersections, and thus the accuracy of the calculated resonance parameters, depends mainly on the strength of the resonance (Γ_n/Γ). Universal analysis curves are plotted for thin and thick samples, and for strong, intermediate, and weak resonances. The curves readily indicate which observables should be used, and roughly what accuracies may be expected for the various cases. Author

N67-18785# Phillips Petroleum Co., Idaho Falls, Idaho.
PROBLEMS ASSOCIATED WITH THE ANALYSIS OF TOTAL CROSS SECTION DATA OF RADIOACTIVE SAMPLES
Ferrol B. Simpson *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 67–74 refs Sponsored by AEC (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

A somewhat different approach must be used in analyzing total cross section measurements taken on radioactive samples because of the contaminants that grow into the sample as a function of time. If the half life of the sample material is short, the decay products can require that sizable corrections be made. In order to take this effect into account, a program has been written which enables one to fit the transmission of the composite data. The technique allows the use of any combination of the Breit–Wigner single level, Reich–Moore multilevel, or Adler multilevel formulas. The first measurements taken on a radioactive sample give thick sample data (low transmissions); measurements taken on the same sample at later times give thin sample data (high transmission). Author

N67-18786# Battelle-Northwest, Richland, Wash.
SENSITIVITY OF REACTOR MULTIPLICATION VALUES TO CROSS SECTION UNCERTAINTIES FOR THERMAL SYSTEMS
R. C. Liikala, W. L. Purcell, and J. R. Worden *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 75–87 refs (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65
(Contract AT(45-1)-1830)

The extent to which the theoretical prediction of reactor multiplications, k_{eff}, is influenced by nuclear data uncertainties is assessed. The experiments and theoretical methods used in the analysis are reviewed; only the nuclear data σ_a and $\nu\sigma_f$ for the

fissile and fertile isotopes of the thermal reactor systems studied are considered. The results of calculations are presented in which the group parameters, Σ_a and $\nu\Sigma_f$, are arbitrarily varied; the variations are also related to corresponding changes in isotopic cross sections. It is concluded that the maximum uncertainty in k_{eff} due to the assumed cross section uncertainties is of the order of 1.0% (10 mk). The uncertainty in resonance cross section data leads to consistently larger uncertainties in k_{eff} than does the uncertainty in thermal cross sections. It is pointed out that this reflects the fact that major emphasis has been placed on the measurement of thermal cross sections and the evaluation of consistent cross section sets for thermal values. M.G.J.

N67-18787# Atomics International, Canoga Park, Calif.
THE SENSITIVITY OF SNAP REACTOR CALCULATIONS TO UNCERTAINTIES IN THE ZIRCONIUM ABSORPTION CROSS SECTION
Eric H. Ottewitte *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 88–90 refs (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65
(Contract AT(11-1)-GEN-8)

About 30% of the atoms in the hydrogen-moderated, U-235 fueled SNAP reactor cores are zirconium. Reported values for the infinitely-dilute zirconium resonance absorption integral (0.4 eV to 2 MeV) have ranged from 3.7 barns to more recent estimates of about 0.9±0.3 barns. A large component of this integral may be present in the 300 eV resonance. This has been assumed in several cross section libraries. The worth of zirconium absorption per barn at 300 eV in a SNAP U-$ZrH_{1.7}$ reactor is 3.0% Δ k/k (by multigroup transport theory code calculation). Assuming the uncertainty in the resonance integral to be 0.3 barns, the uncertainty in a SNAP reactor calculation would then be ±0.9% Δ k/k without considering the degree of resonance self-shielding. With proper treatment of the self-shielding it would be less. The value of the resonance self-shielding will depend on whether the absorption resonance integral is distributed over the resonance energy range or whether it is concentrated in a single resonance such as the 300 eV resonance. Author

N67-18788# General Dynamics Corp., San Diego, Calif. General Atomic Div.
THE INFLUENCE OF NEUTRON CROSS SECTIONS ON THERMAL REACTOR SPECTRA
J. R. Beyster and J. M. Neill *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 91–112 refs (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65
(Contract AT(04-3)-167)

For many applications thermal reactor spectra must be predicted with accuracy. The thermal spectra are determined by the scattering and absorption properties of the reactor medium. Absorption cross section data are generally obtained from standard compilations while reliable scattering cross section information is more difficult to obtain. Procedures for generating these data for spectral calculations and the degree to which spectra can now be predicted in thermal reactor systems are discussed. Examples of spectral problems involving the quality of absorption and scattering cross section data are given. Other factors influencing the ability to calculate thermal reactor spectra are also presented. Author

N67-18789# General Electric Co., Schenectady, N. Y. Knolls Atomic Power Lab.
CROSS SECTION SENSITIVITY CALCULATIONS FOR SMALL HYDROGEN MODERATED SYSTEMS
S. Weinstein, F. Feiner, K. V. Cooper and S. I. Armstrong *In* AEC Neutron Cross Sect. Technol. Mar. 1966 p 113–121 refs (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

Experiments were performed with the KAPL solid homogeneous assembly. The cores built on the assembly are leakage dominated and were designed to have an enhanced sensitivity to high energy cross sections. Sensitivity calculations were made using evaluated microscopic cross sections for oxygen, zirconium, carbon, and uranium 235. NSA

N67-18790# Rensselaer Polytechnic Inst., Troy, N. Y.
POLYETHYLENE DOUBLE DIFFERENTIAL INELASTIC SCATTERING CROSS SECTIONS FOR EPITHERMAL NEUTRONS
G. J. Kirouac, W. E. Moore, K. W. Seemann, and M. L. Yeater *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 122–133 refs Sponsored by AEC (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

As part of a program to study neutron interactions with reactor moderators, scattering cross sections have been measured for polyethylene at three angles (25°, 60° and 90°) and nine incident neutron energies between 0.15 eV and 1.8 eV. Banks of 10 atm He^3 filled proportional counters located 1.85 m from the sample detected the scattered neutrons. Cross sections were determined relative to a vanadium scattering target and the scattering law was constructed. Author

N67-18791# Argonne National Lab., Ill.
THE CHEMICAL BINDING EFFECTS ON THE RESONANCE LINE SHAPES OF URANIUM-238 IN A UO_2 LATTICE
C. R. Adkins (Ph. D. Thesis—Carnegie Inst. of Tech.), P. J. Persiani, R. N. Hwang, and J. J. Kaganove *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 134–154 refs (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

The asymmetry and shift of the Breit–Wigner line shape were studied for selected energy levels at temperatures of 50°K, 300°K and 1500°K. The line shape of the cross sections were developed in a manner similar to that used for absorption. The phonon frequency spectra were based on the Born–Von Karman description of a crystal and made consistent with specific heat data. Experimentally determined phonon distribution was also included in the study. In general, pronounced crystalline effect on the line shifts and asymmetries with respect to the gas model and the weak binding approximation prevailed at the higher temperatures for the low lying levels. Slight line shifts were also noted for the higher energy resonances at the lower temperatures. The changes in the capture resonance integrals due to Doppler broadening were found to differ appreciably between the various models at the lower temperatures and lower energy levels. The crystalline effects on the interference and resonance scattering were included in resonance integral computations. Author

N67-18792# Battelle-Northwest, Richland, Wash.
SENSITIVITY OF THERMAL REACTOR PARAMETERS TO SCATTERING MODEL
J. R. Worden, W. L. Purcell, and R. C. Liikala *In* AEC Neutron Cross Section. Technol. Mar. 1966 p 146–150 refs (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65
(Contract AT(45-1)-1830)

Comparative studies have been carried out to determine the effect of the choice of scattering model for the common moderating materials, H_2O, D_2O, and graphite, on calculated reactor parameters. Calculations of the thermal reproduction factor, η, and the thermal utilization, f, have been made for uranium and/or plutonium for which measured values of parameters are available. The calculations were performed using the thermalization code, THERMOS, in conjunction with kernels generated using various scattering models. It is concluded that scattering in graphite is adequately represented by the Parks' kernel if the criterion for adequacy is matching the core parameters, η and f. This has been confirmed for systems containing uranium only and both uranium

and plutonium where, in each case, calculated values of the parameters agree with those measured within the experimental uncertainty. The inadequacy of the free gas model for graphite is exhibited by discrepancies of 1 to 2 percent in the calculated value of f. It is shown that neglecting anisotropic scattering in H_2O leads to large errors in calculated parameters. Results of the study of scattering in D_2O are not conclusive and indicate the need for further study of simpler systems. Author (NSA)

N67-18793# Du Pont De Nemours (E. I.) and Co., Aiken, Savannah River Lab.

THE SENSITIVITY OF D_2O MODERATED REACTOR PARAMETERS TO THERMAL NEUTRON SCATTERING LAW

John E. Suich *In* AEC Neutron Cross Sect. Technol. Mar. 1966 p 151–170 refs (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

(Contract AT(07-2)-1)

Experimental neutron spectrum results are compared with theoretical calculations. The experience of other installations interested in D_2O reactor physics was utilized. The sensitivity of D_2O moderated reactor parameters to the details of the thermal neutron scattering law is evaluated. The more sophisticated models produce errors of a few tenths of 1% in reactivity, perhaps 1–2% in conversion ratios, and 10–15% in temperature coefficients. Author

N67-18794# Florida Univ., Gainsville. Dept. of Nuclear Engineering Sciences.

THE RESONANCE ABSORPTION INTEGRAL OF RHENIUM

R. A. Karam and T. F. Parkinson *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 171–181 refs (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

(Contract NOas-60-6021-C)

Early measurements of the resonance absorption integral of elemental rhenium gave values of 567 and 524 b (without 1/v absorption); this compares to calculated values of 799 and 1156 b. We have remeasured the activation resonance integral and obtained 657±28 b (excluding 1/v absorption) for a lower energy limit of 0.53 eV. This value is based on the resonance integral of gold (1558b) and also depends on the thermal activation cross sections of Re^{185} and Re^{187}. When the uncertainties in these cross sections are considered, the cumulative error in our value is estimated to be ±125 b. Author

N67-18795# General Dynamics Corp., San Diego, Calif. General Atomic Div.

THE NEUTRON CAPTURE CROSS SECTION OF THE TUNGSTEN ISOTOPES FROM 0.01 TO 10 ELECTRON VOLTS

S. J. Friesenhahn, E. Haddad, F. H. Frohner, and W. M. Lopez *In* AEC Neutron Cross Sect. Technol. Mar. 1966 p 182–203 refs (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

(Contract SNPC-27)

Capture cross section measurements from 0.01 to 10 eV on W^{182}, W^{183}, W^{184}, and W^{186} employing a totally absorbing gamma ray detector are described. The 2200 m/sec value of the capture cross section is compared with previously reported measurements, and the shape and magnitude of the cross section curve are compared with calculations using reported resonance parameters. Parameters of negative energy levels required to account for the discrepancy between measured and calculated cross sections for W^{182} and W^{184} are given. A measurement of the gold capture cross section is used as a check on the techniques employed. Author

N67-18796# Atomics International, Canoga Park, Calif.

EFFECTS OF PREPOISON CROSS SECTION UNCERTAINTIES ON SNAP REACTOR PERFORMANCE

K. R. Birney, J. P. Hawley, and D. J. McGoff *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 204–209 (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

(Contract AT(11-1)-GEN-8)

During the SNAP 10A ground demonstration test and SNAPSHOT flight test, an error in prediction of the samarium-149 cross section introduced larger-than-predicted temperature decreases during lifetime. Although this error was caused primarily by spectral effects rather than errors in pointwise cross section data, the same uncertainties are introduced by cross section uncertainties when poisons having less well-known cross sections are used. Poisons presently under consideration include isotopes of gadolinium and europium. The particular isotope or combination to be used is determined by reactor power and temperature. Author

N67-18797# General Electric Co., Schenectady, N. Y. Knolls Atomic Power Lab.

PREPARATION OF EVALUATED CROSS SECTION LIBRARIES

C. R. Lubitz *In* AEC Neutron Cross Sect. Technol. Mar. 1966 213–226 (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

(Contract W-31-109-ENG-52)

The process of putting together a library of neutron cross sections for use in reactor and shielding calculations is discussed. Brief descriptions are given of a modular, user-oriented, automated data handling and computational system designed for a high-speed computer. The theoretical methods used for interpolation and extrapolation of experimental results are discussed, as well as the problems associated with feeding back experimental information into the libraries. A number of problems concerning the status of cross section measurements and the methods of reporting them are enumerated, emphasizing those experimental points of particular importance in the evaluation process. Author

N67-18802# Atomics International, Canoga Park, Calif.

PERTURBATION THEORY IN BURNUP CALCULATIONS

E. U. Vaughan *In* AEC Neutron Cross Sect. Technol. Mar. 1966 p 259–269 refs (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

(Contracts AT(11-1-GEN-8); AT(38-1)-388)

A perturbation theory for reactor burnup calculations has been developed, and applied to perturbations of the limiting lifetime, beyond which the reactor cannot achieve criticality. Because of the non-linearity of the burnup equations, the flux and composition variables do not have adjoints, but sufficiently small variations of these variables satisfy linear equations, and consequently do have adjoints. A FORTRAN IV program has been written to calculate burnup histories for a simple two-group point-burnup model, and to utilize such histories to set up and solve the associated adjoint equations. Some calculations with this program are reported. Author

N67-18803# Atomics International, Canoga Park, Calif.

NEUTRON CROSS-SECTION EVALUATION BY AIDA, AUTOMATED INSPECTION OF DATA

Barbara J. Lemke *In* AEC Neutron Cross Sect. Technol. Mar. 1966 p 270–286 refs (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

(Contract AT(11-1)-GEN-8)

A FORTRAN IV program, AIDA, has been developed at Atomics International to aid in the evaluation of available nuclear data files. Aldermaston, Livermore Radiation Laboratory and Los Alamos, and Atomics International data files are acceptable to AIDA. The program plots selected cross-sections from one data file according to the scale, log-log or semi-log, specified by the user; or, in overlay form, from two data files according to the scale specified by the program. Up to 901 energy points can be handled. Results of cross-section evaluations, and additional features of AIDA are presented. Author

N67-18804# Columbia Univ., New York.
CORRELATING THE ENERGY CALIBRATION OF NEUTRON VELOCITY SPECTROMETERS
S. A. R. Wynchank *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 287–292 (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

A description is given of the factors which affect energy determinations in the measurement of cross sections by time-of-flight methods. The establishment of "Zero Time" and effects of detector size and response are considered. Possible improvements in timing at the Columbia University Nevis Synchrocyclotron, by the use of a spark gap for the proton beam deflection and a phase correlation between the accelerating rf and the deflection pulse are outlined. The value of intercomparison of data obtained from different laboratories is stressed, with especial regard to consistant energy differences between them. Author

N67-18806# Californis Inst. of Tech., Pasadena.
USE OF INTEGRAL MEASUREMENTS AS SUPPLEMENTARY DATA FOR DETERMINING NEUTRON CROSS-SECTIONS
G. Rakavy *In* AEC Neutron Cross Sect. Technol. Mar. 1966 p 304–308 (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65
(Contract Nonr-220(47); Grant NSF GP-5391)

Neutron cross-section data can be improved systematically by using the accurate data from critical mass measurements along with data on neutron spectra in critical and subcritical assemblies and direct measurements of cross-sections, in a unified least square procedure. The cross-sections thus obtained are expected to yield very accurate results in reactor calculations. The method can also be used to check the consistency of measurements on various critical and subcritical assemblies with each other and with the available cross-section data. Author

N67-18807# ITT Research Inst., Chicago, Ill.
A COMPREHENSIVE COMPUTER LIBRARY OF NEUTRON ACTIVATION CROSS SECTIONS
D. A. Klopp *In* AEC Neutron Cross Sect. Technol. Mar. 1966 p 309–314 refs Sponsored by NASA (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

A computer library of (n,γ), (n,p), (n,α), and (N,2n) cross sections has been constructed for use in computer calculations of neutron activation. Data for well over 200 different isotopes are represented by average cross sections for 43 neutron energy groups spanning the energy range from 21 MeV to thermal. Resonance parameters of as many as nine different resonances are tabulated for each isotope. These data have been augmented by statistical model calculations of (n,γ) group cross sections in the unresolved resonance energy region. Author

N67-18811# General Electric Co., San Jose, Calif. Atomic Products Div.
USER REQUIREMENTS FOR CROSS SECTIONS IN THE ENERGY RANGE FROM 100 eV to 100 KeV
P. Greebler and B. A. Hutchins *In* AEC Neutron Cross Sect. Technol. Mar. 1966 p 357–380 refs (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

A comprehensive evaluation is made of the sensitivity of important physics parameters of large fast power reactors to uncertainties in the cross-section data between 100 eV and 100 KeV. Reactors using U-Pu and U-Th fuel cycles, oxide and carbide fuels, sodium and steam coolants, and a broad variation in neutron leakage and spectrum were considered. Satisfactory accuracy in the computations of fissile mass (±1%), breeding ratio (±1%), Doppler coefficient (±5%), and sodium void reactivity (±0.5%) requires accuracies of ±3% for $\sigma_{(n,f)}$ of Pu-239 (or U-233) and $\sigma_{(n,\gamma)}$ of U-238 (or Th-232); ±5% for $\sigma_{(n,\gamma)}$ of Pu-239 and Pu-240 and $\sigma_{(n,f)}$ of Pu-241; ±10% for $\sigma_{(n,\gamma)}$ of combined fission products, and important clad materials. Author

N67-18814# Argonne National Lab., Ill.
CROSS SECTION UNCERTAINTIES AND REACTOR SAFETY
David Okrent *In* AEC Neutron Cross Sect. Technol. Mar. 1966 p 430–453 refs Sponsored by AEC (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

In this paper, illustrations are given of the major role played by the Doppler coefficient in limiting the consequences of severe reactivity excursions, both in sodium-cooled fast reactors and in water-cooled and moderated thermal reactors. Also discussed is the delicate balance between opposing phenomena which yield major reactivity contributions to the sodium void reactivity coefficient in large fast reactors, and the interrelation between Doppler effect and positive sodium void effect in accident studies which involve large reactivity insertion rates due to boiling and expulsion of sodium in the presence of a net positive void effect on reactivity. The manner in which uncertainties in U^{233} fission and capture can lead to a question in sign of the moderator coefficient for gas-cooled reactors is illustrated, and the importance of high energy scattering cross sections to possible embrittlement of reactor pressure vessels is treated. Author

N67-18819# Brookhaven National Lab., Upton, N. Y.
NUMERICAL ANALYSES OF NEUTRON RESONANCES BY USE OF COMPUTER PROGRAMS
M. R. Bhat, R. E. Chrien, and I. W. Cole *In* AEC Neutron Cross Sect. Technol. Mar. 1966 p 522–531 refs Sponsored by AEC (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

The use of computer-oriented, automated techniques in the analysis of slow neutron cross sections is described, with special emphasis on the measurement of neutron resonance parameters. The application of these techniques is illustrated at each stage of the data reduction process. A description of the determination of the resolution function for the BNL chopper time-of-flight system is given. The results of resonance analysis with a non-Gaussian resolution function are presented. Author (NSA)

N67-18821# Atomic Energy Commission, Washington, D. C. Div. of Technical Information.
NEUTRON CROSS SECTION TECHNOLOGY
P. B. Hemmig, ed. 24 Mar. 1966 557 p refs Proc. held in Washington, D. C. 22–24 Mar. 1966 Sponsored by AEC, Am. Phys. Soc., NBS, and Am. Nucl. Soc.
(CONF-660303, Bk. 2) CFSTI: HC $3.00/MF $0.65

Conference papers are presented on the cross section needs, and measurements in the neutron energy range above 100 KeV, and on special problems in the measurement and use of fission cross sections. Future requirements and capabilities are also considered. For individual abstracts, see N67-18822 through N67-18871.

N67-18822# Los Alamos Scientific Lab., N. Mex.
CRITICALITY DEPENDENCE ON NEUTRON CROSS SECTIONS ABOVE 100 KeV
Gordon E. Hansen *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 557–561 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

The influence of fast-neutron cross sections on criticality is sketched in a qualitative manner and with little reference to specific reactor concepts. First, infinite media are considered and the energy range limited to above the U-238 fission threshold where well-defined removal cross sections exist from which one can portion out the probabilities of various fast capture or fission reactions. Second, the energy range is extended downward towards 100 KeV where the usefulness of removal cross sections diminish and details of neutron energy-reduction processes become more important. Finally, the one-group diffusion approximation for critical dimension is introduced as a basis for inferring criticality dependence on flux-weighted cross sections. Author

N67-18831# Northrop Space Labs., Hawthorne, Calif.
EFFECT OF THRESHOLD CROSS SECTION ON THE DERIVATION OF FAST-NEUTRON SPECTRA
S. H. Levine and R. E. Fortney *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 660–674 refs (See N67-18821 08-24) CFSTI: HC$3.00/MF$0.65

The effect of errors in cross section data on deriving fast-neutron spectra between 1 and 10 Mev from experimental threshold activation data has been studied arbitrarily varying published cross sections about a reference set of cross section data. The study utilizes an iteration method which derives a spectrum that is a function of experimental data only; $Np^{237}(n,f)$, $U^{238}(n,f)$, $S^{32}(n,p)$, $Al^{27}(n,p)$, $Fe^{56}(n,p)$ and $Al^{27}(n,\alpha)$ reactions are used in this study. Also, the importance of these spectral changes are discussed in reference to important parameters and spectral shapes. Author

N67-18844# Phillips Petroleum Co., Idaho Falls, Idaho.
THE INTERPRETATION AND EVALUATION OF INTEGRAL CROSS SECTIONS BY REACTIVITY MEASUREMENTS
J. J. Scoville and E. Fast *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 773–781 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC$3.00/MF$0.65

The importance of reactivity measurement of integral cross sections is discussed. The investigator should either make the measurements in a pure 1/E dependent flux, or be able to correct for any departure from this idealistic condition. Calculational methods are employed to make these, along with other possible corrections for fast fission, (n,2n'), and inelastic scattering reactions. Since many materials do not activate upon neutron absorption, the reactivity technique is important in determining their resonance integrals. Some results determined with the ARMF reactors by static reactivity measurements are included. Author

N67-18845# General Dynamics Corp., San Diego, Calif. General Atomic Div.
ADEQUACY OF FAST AND INTERMEDIATE CROSS SECTION DATA FROM MEASUREMENT OF NEUTRON SPECTRAL IN BULK MEDIA
J. L. Russell, Jr. and A. E. Profio *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 782–795 refs (See N67-18821 08-24) CFSTI: HC$3.00/MF$0.65

Methods used to calculate intermediate neutron spectra in fast reactors are suspect because of inadequacies in cross section data as well as approximations used in preparing (group averaging) cross section data for transport codes. Direct measurement of neutron spectrum in bulk media provides a means of evaluating discrepancies. The status of spectrum measurements is reviewed. preliminary results of spectrum measurements are discussed, and some new measurement concepts are described. Author

N67-18846# Argonne National Lab., Ill.
A CRITICAL EVALUATION OF FAST FISSION CROSS SECTIONS
William G. Davey *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 796–808 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC$3.00/MF$0.65

The published cross sections of U-235, U-238, Pu-239 and Pu-240 from 1 keV to 10MeV were studied to select best cross sections for fast reactor analysis. Emphasis was placed on determining the reference data used and, where necessary, revising the measurements to accord with currently accepted cross sections. Some checks were made by comparing calculations based on the selected cross sections with integral measurements in the fission spectrum and in 19 fast reactor critical assemblies. The study shows a clear need for more work on precise fission cross sections, particularly that of U-235 since it is widely used as a reference. Author

N67-18847# Argonne National Lab., Ill.
SENSITIVITY OF FAST REACTOR PARAMETERS TO CROSS SECTION UNCERTAINTIES
Harry H. Hummel *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 809–820 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC$3.00/MF$0.65

Recent comparison calculations showed discrepancies in the results from various organizations that would be equivalent to 2% k for complete voiding of sodium from a reactor core. These discrepancies arose primarily from differences in the energy variation of the neutron importance function because of differences in assumed fission and capture cross sections. A difference was found in assumed Pu-239 fission and capture cross sections and U-238 capture cross sections, particularly at energies below 100 keV. These differences ranged up to a factor of two in the former case and to 50% in the latter. In the former case this may really represent the range of uncertainty. In the latter, however, use of the latest resonance parameters for U^{238} would have reduced discrepancies. Variation in assumed Pu^{240} and fission product capture cross sections give smaller effects. There was also a large disagreement in calculated critical masses for very dilute reactors which at present appears also to be due to differences in assumed Pu-239 fission and U-238 capture, particularly at low energies. Author

N67-18848# Westinghouse Electric Corp., Pittsburgh, Pa. Bettis Atomic Power Lab.
FISSION RESONANCE CROSS SECTION REQUIREMENTS FOR REACTOR DESIGN
D. R. Harris *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 823–839 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC$3.00/MF$0.65

Cross section requirements for reactor design are reviewed for the fissile nuclides in the resonance energy range. The types of cross sections required, their required accuracies and storage forms are examined. Use of the Reich and Moore multilevel-multichannel analysis for storage of resonant cross sections is recommended. Author

N67-18856# Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.
PREPARATION OF MICROSCOPIC CROSS SECTIONS OF U^{235} FOR REACTOR CALCULATIONS
Donald W. Drawbaugh and Gordon Gibson *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 939–963 refs (See N67-18821 08-24) CFSTI: HC$3.00/MF$0.65

A set of resonance parameters for the resolved range is given. The origin of these parameters is described. Of importance for reactor calculations is a table which gives the smooth (temperature independent) background cross sections which must be added in order to bring the single-level theoretical cross sections into agreement with experiment. The Saclay experimental data has been used; the corresponding Doppler broadening and experimental resolution have been taken into account in the calculations. This representation for the cross sections is of value for calculations concerning nuclear rocket reactors (NERVA) which operate at high temperatures, and for which a large fraction of the fissions are induced by epithermal neutrons. Author (NSA)

N67-18857# Atomics International, Canoga Park, Calif.
NEED FOR Pu-238 AND Cm-244 CROSS SECTION DATA
Eric H. Ottewitte and Vahe Keshishian *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 964–970 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC$3.00/MF$0.65

Plutonium-238 and Curium-244 promise to be excellent radioisotope heat sources. The question of criticality arises when either of these materials are assembled in large quantity. To calculate the criticality of these systems one requires information

about the neutron-interaction parameters, particularly ν the number of secondary neutrons produced per fission and the fission cross section σ_f. Calculations based on theoretical estimates of ν, σ_f, and the other nuclear parameters have shown remarkable agreement with material replacement experiments. Still, there have been very few measurements for σ_f and none for ν. One particularly interesting measurement which might be possible would be the determination of the neutron yield ν from the (low decay rate) spontaneous fission of Pu-239, the compound nucleus of Pu-238. Author

N67-18858# Los Alamos Scientific Lab., N. Mex.
FISSION CROSS SECTION OF U-235, 20 eV–2MeV
Wilbur K. Brown, D. W. Bergen, and J. D. Cramer *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 971–978 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

The fission cross section of U-235 has been measured by time-of-flight using neutrons generated by an underground nuclear explosion. A high-intensity flux was obtained from 20 eV to 2 MeV, and the fission cross sections of several isotopes including U-233, U-235, and Pu-239 were measured relative to each other. The $Li^6(n,\alpha)T$ reaction was used to measure the energy-dependent flux up to about 100 keV; and from 10keV to 2 MeV, the $U^{235}(n,f)$ reaction was used for this purpose. Cross sections of all other isotopes were determined using this flux, and comparison of all these cross sections with presently available data served to anchor the matrix. Data are presented which exhibit good resolution in the resonance region with lower backgrounds than previous measurements. The peak-to-valley ratios agree with Harwell measurements. Absolute values are in excellent agreement with the data of Bowman at low energies. Author

N67-18864# General Electric Co., New York.
FUTURE CROSS SECTION NEEDS OF THE NUCLEAR POWER INDUSTRY
Thomas M. Snyder *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 1025–1034 refs (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

As the nuclear power industry grows to a position of dominance in the generation of electrical power, the industry needs for neutron cross section data will swing towards the goals of efficient utilization of the enormous by-product isotope production capacity, accurate measurement of nuclear fuel burn-up performance using fission product isotope concentrations, meaningful monitoring of the radiation damage potential of fast neutron fluxes with convenient neutron threshold reactions, and a broad grasp of the nuclear properties of the actinides relevant to criticality and nuclear safety. These data needs are discussed in detail. Author

N67-18869# Florida Univ., Gainesville. Dept. of Nuclear Engineering Sciences.
THE NEUTRON DECAY SPECTROMETER–A NEW TOOL FOR NEUTRON SPECTROMETRY AND CROSS-SECTION MEASUREMENTS
T. F. Parkinson, J. J. Woods, and T. Yang *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 1073–1083 refs (See N67-18821 08-23) CFSTI: HC $3.00/MF $0.65
(Grant NSF GP-3214)

The neutron decay spectrometer (NDS) depends on the spectral analysis of the proton and beta particles that originate from neutron decay. Preliminary work demonstrated the feasibility of the method. The resolution of the NDS was using epithermal neutrons generated by the Be(p,n) and Li(p,n) reactions from the Van de Graaff accelerator. For improved resolution, coincidence counting techniques have been employed using a neutron beam from a reactor. Author

N67-18872# Idaho Nuclear Corp., Idaho Falls.
COMPUTER CODE FOR THE CALCULATION OF FUEL AND POISON CROSS SECTIONS FROM REACTIVITY MEASUREMENTS
Robert G. Nisle, R. A. Peereboom, D. J. Aller, and K. J. Anderson Aug. 1966 14 p refs
(Contract AT(10-1)-1230)
(IN-1017) CFSTI: HC $3.00/MF $0.65

Transient reactivity measurements on irradiated fuel samples provide a means for measuring fuel content and gross fission product cross sections by a nondestructive method. When an appreciable amount of self-shielding is present, the reactor response is no longer a linear function of content. In that case the pertinent equations involve algebraic and exponential terms. Hence an iterative procedure must be used. This program, therefore, solves for fuel and poison content by means of a double iteration for fuel cross section and for poison cross section by the use of reactivity measurements made in two measuring locations having different relative worths for neutron absorption (primarily thermal) and for neutron production. Author (NSA)

N67-18873# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
WASHOUT TESTING OF MIXED OXIDE CERAMIC CORE FUEL ELEMENTS
K. D. Hayden Oct. 1966 14 p refs
(Contract AT(45-1)-1830)
(BNWL-295) CFSTI: HC $3.00/MF $0.65

The washout of core material following fuel element failure was evaluated in the Irradiated Rupture Prototype (IRP) Loop. The irradiated elements were defected with a long slit and placed in a shielded test which was connected directly to the loop. The water in the loop was then heated, and the test was run for several weeks. The release of core material was determined by weighing the fuel element, by visual inspection, and by continuous measurements of activity levels in different portions of the loop. It was found that swaged elements tend to be more resistant to washout than vibrationally compacted elements. It was also found that the amount of core material washed out depends on the amount of vibration and that core washout without externally applied vibration tends to be small even with large defects in the cladding. NSA

N67-18880# Brookhaven National Lab., Upton, N. Y.
HIGH-TEMPERATURE LIQUID-METAL TECHNOLOGY REVIEW, VOLUME 4, NUMBER 3 Bimonthly Technical Progress Review
Jun. 1966 52 p refs
(Contract AT(30-2)-GEN-16)
(BNL-50003(PR-21) CFSTI: HC $3.00/MF $0.65

Included are summaries of 23 research projects dealing with the following aspects of high-temperature liquid-metal technology: physical properties and thermodynamics, fluid dynamics, heat transfer, materials development and corrosion, instrumentation, component development, systems studies, chemistry and chemical analysis, and fabrication techniques. NSA

N67-18881# Du Pont De Nemours (E. I.) and Co., Wilmington, Del. Reactor Engineering Section.
HEAT TRANSFER STUDIES FOR THE D_2O POWER REACTOR PROGRAM. A TERMINAL STATUS REPORT OF THE WORK AT COLUMBIA UNIVERSITY
John S. Neill Aug. 1966 79 p refs
(Contract AT(07-2)-1)
(DP-1024) CFSTI: HC $3.00/MF $0.65

Experiments relating to the heat transfer capability of fuel assemblies for a nuclear power reactor were conducted at the

Heat Transfer Research Facility of Columbia University. The heat flux at burnout with forced flow of subcooled and boiling water at high pressure was measured for several types of assemblies: multirod bundles in a circular housing, tubular channels, internally heated annuli, tubes-in-parallel, and tubes cooled on both the inner and outer surfaces. The relation of the particular tests to the development program for a heavy-water-moderated power reactor is discussed. The results, together with the recent results from other laboratories, are applied to a nested-tube-assembly design for a D_2O-cooled power reactor. Areas for further investigation are pointed out. Author (NSA)

N67-18883# Argonne National Lab., Ill. Applied Mathematics Div.

GENERAL INPUT SPECIFICATIONS FOR ANL REACTOR PROGRAMS

M. Butler and H. Greenspan Apr. 1966 38 p ref

(Contract W-31-109-ENG-38)

(ANL-7194) CFSTI: HC $3.00/MF $0.65

Standard-problem specifications are presented for the programming of multigroup diffusion and transport programs for the CDC-3600. Seven categories for input specifications are discussed: identification and program-dependent input data, geometry, boundary and interface conditions, material assignment, type designation, initial source/flux values, and cross-section modification. NSA

N67-18886# Atomics International, Canoga Park, Calif.

MERCURY RANKINE PROGRAM, INTEGRATED SYSTEM TEST (PSM-3). VOLUME I: SYSTEM OPERATION

25 Oct. 1966 114 p

(Contract AT(11-1)-GEN-8)

(NAA-SR-11945, Vol. I) CFSTI: HC $3.00/MF $0.65

A complete non nuclear mercury Rankine orbital startup simulator system producing an average of about 3 kW(e) was successfully fabricated and operated for 706 hr. and 108 startups. The system, designated PSM-3, was the third in a series of three Prototype System Mockups fabricated and operated at Atomics International as part of the SNAP-2 program (later redirected as the Mercury Rankine Program). The major objectives and accomplishments of the system test, the program plan, test operations, and an evaluation of the test results with regard to the Mercury Rankine Program are described. Volume II presents the detailed analysis and correlation of the test data. Author (NSA)

N67-18891# Atomics International, Canoga Park, Calif.

AEC UNCLASSIFIED PROGRAMS, FISCAL YEAR 1966 Annual Technical Progress Report

31 Aug. 1966 298 p refs

(Contract AT(11-1)-GEN-8)

(NAA-SR-12010) CFSTI: HC $3.00/MF $0.65

Fast reactor development activities included a secondary Na-steam system parameter study, boiling studies for Na reactor safety, UC fuel irradiation, and stability and property studies of cladding and structural alloys in a high-temperature, liquid metal, fast neutron environment. Assessment of the safety, design, and operational reliability of the Sodium Reactor Experiment was continued. The operation of the Sodium Component Test Installation was limited by failure of major system components. A Liquid Metals Information Center was established. Various materials and mechanical devices, including strain gages, spur gears, and journal bearings, were tested in high-temperature sodium. Piqua Nuclear Power Facility development activities included fabrication of Core II, SAP-clad, UC fuel elements, Core II design, and design of a catalytic hydrocracking coolant processing system. Extrapolation lengths and neutron diffusion lengths were measured in graphite and water and pulsed neutron decay measurements in diphenyl were completed. Existing experimental and theoretical data on neutron cross sections were surveyed, compiled, and evaluated, and a number of neutronic computer codes were written or modified. Measurement were obtained on the Doppler effect in a fast reactor spectrum, and a computer code is being developed for the calculation of region-dependent spectra for fast reactors. Reactor fuels and materials studies included structure, properties and fission effects in UC and other refractory, interstitial fuels, refractory moderator materials development, fission effects in metal fuels, and synthesis, structure, and behavior of metal-hydrogen systems. Sodium chemistry development was concentrated on methods for the preparation of ultra-pure Na and analysis techniques for impurities in Na. A high-flux heater to simulate fast-reactor fuel pins was built and tested. Development of the digital dynamics simulator AIROS was continued, and TRIX code calculations of the Doppler coefficient of reactivity and associated resonance parameters were compared with measured values. The ability of Na reactor coolants to retain specific fission products released to the coolant stream and the behavior of these fission products in the coolant were investigated. Extensive experiments were conducted on the characterization of Na fires and the release and transport of effluents and energy in a primary coolant accident. An analytical model was developed for calculation of energy and gas transport resulting from a Na fire. The high-temperature physico-chemical properties of fused salts and metal–metal salt solutions were studied, and the fundamental physico-chemical processes occurring in the radiolysis of organic systems were investigated. Work was continued on various aspects of superconductivity in metals and alloys, and radiation damage and recovery processes were examined for metals, alloys, and semiconductors. NSA

N67-18892# Atomics International, Canoga Park, Calif.

COMPILATION, EVALUATION AND PRODUCTION OF NUCLEAR DATA FOR REACTOR CALCULATIONS

Harry Alter and Charles L. Dunford 15 Aug. 1966 36 p refs

(Contract AT(11-1)-GEN-8)

(NAA-SR-11980, Vol. I) CFSTI: HC $3.00/MF $0.65

A system for the evaluation and processing of nuclear data is briefly described, and some improvements in methods of evaluation of nuclear data are recommended. Author (NSA)

N67-18893# Atomics International, Canoga Park, Calif.

GRISM—A CODE TO GENERATE MULTIGROUP CONSTANTS FROM MICROSCOPIC NEUTRON CROSS SECTION DATA

R. C. Lewis, R. A. Blaine, F. L. Fillmore, B. J. Lemke, B. D. O'Reilly et al 15 Sep. 1966 86 p refs

(Contract AT(11-1)-GEN-8)

(NAA-SR-11980, Vol. III) CFSTI: HC $3.00/MF $0.65

Input data from the Atomics International Evaluated Nuclear Data File (AIENDF) tape are processed to give spectrum-weighted group-averaged neutron cross sections and other quantities required for the solution of the neutron transport equation by multigroup diffusion and transport theory methods. The calculation of multigroup Doppler-broadened effective resonance integrals and cross sections in the resonance region for a heterogeneous or homogeneous resonance absorber is based on the single-level Breit-Wigner theory with no overlapping of neighboring resonances. Inelastic and elastic scattering transfer matrices are calculated using differential scattering cross section data stored on the AIENDF Angular Distribution Data Tape (ADDT). Multigroup libraries are punched in any of the formats required by the one-dimensional multigroup diffusion theory codes, ULCER, FAIM, FAIM-CELL, CAESAR, and CAESAR IV; the one-dimensional multigroup S_n transport theory code, DTF; and the spectrum codes, FORM and AILMOE. Author (NSA)

N67-18899# Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.

PROPERTIES OF ^{60}Co AND COBALT METAL FUEL FORMS

William C. Windley, Jr. Oct. 1966 23 p refs
(Contract AT(07-2)-1)
(DP-1051, Rev. 1) CFSTI: HC $3.00/MF $0.65

A compilation of the properties of Co^{60} and cobalt metal, including information on the compatibility of cobalt with possible encapsulating materials is presented. NSA

N67-18913# Atomics International, Canoga Park, Calif.
STARTUP AND OPERATION OF THE ONE-MEGAWATT SHIELD TEST AND IRRADIATION REACTOR
K. G. Randen and K. G. Golliher 25 Mar. 1966 38 p refs
(Contract AT(11-1)-GEN-8)
(NAA-SR-11175) CFSTI: HC $3.00/MF $0.65

Experiments performed in connection with the startup of the 1-Mw core and operating experience gained during its first six months of operation are described. The reactor was first made critical on December 7, 1964, and was taken to full power for the first time on January 6, 1965. Some of the experiments described were completed subsequent to the first full power run. NSA

N67-18918# Atomics International, Canoga Park, Calif.
IRRADIATION BEHAVIOR OF UNALLOYED HYPOSTOICHIOMETRIC URANIUM CARBIDE, EXPERIMENT AI 3-11 AND REVIEW
J. E. Frank, R. E. Forrester, and J. S. Buck 15 Jul. 1966 49 p refs
(Contract AT(11-1)-GEN-8)
(NAA-SR-11440) CFSTI: HC $3.00/MF $0.65

As part of the Large Sodium Graphite Reactor (LSGR) Development Program, uranium carbide fuels have been subjected to considerable study at Atomics International over the past several years. One phase of this work concerned itself with the study of the in-pile performance of hypostoichiometric uranium carbide. Included are the results of in-pile tests conducted to date for temperature, burnup, power conditions, and UC fuel compositions consistent with LSGR program requirements. More specifically, it deals with the results of the AI 3-11 experiment, which was successfully irradiated at LSGR conditions ($1600°F < T_{Centerline} < 1800°F$) to a peak burnup level of 30,000 Mwd/MTU. The results of the AI 3-11 experiment, along with previous tests: (1) demonstrate the feasibility of utilizing hypostoichiometric uranium carbide fuels, sodium bonded to Type 304 stainless steel cladding, under LSGR conditions to burnup levels of at least 30,000 Mwd/MTU, (2) indicate the fuel volume increases are directly proportional to burnup, to at least 30,000 Mwd/MTU, and (3) suggest UC fuel volume changes are composition dependent. Author (NSA)

N67-18917# Atomics International, Canoga Park, Calif.
2-PLUS, A NONSPHERICAL OPTICAL MODEL FOR FAST NEUTRON CROSS SECTIONS
C. L. Dunford 15 Jul. 1966 93 p refs
(Contract AT(11-1)-GEN-8)
(NAA-SR-11706) CFSTI: HC $3.00/MF $0.65

The 2-PLUS computer code is written in FORTRAN II for the IBM-7094 to solve the problem of the scattering of nucleons by a deformed nuclear potential. It is assumed that the ground state (0^+) and the first excited level (2^+) are strongly coupled by the deformed potential. All other levels are treated in the weak coupling limit (spherical potential). A compound nucleus theory is included so that lower energy neutron scattering may be calculated. Elastic and inelastic cross sections, as well as angular distributions, may be calculated. These calculated cross sections may be plotted and compared with experimental data by the code. Author (NSA)

N67-18960# Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.
SAXTON PLUTONIUM PROGRAM Quarterly Progress Report, Period Ending 31 Dec. 1964
N. R. Nelson Brussels, EURATOM, Feb. 1966 93 p refs
(Contract AT(30-1)-3385)
(EURAEC-1304; EUR-2679.e, Pt. II)

One and two dimensional burn-up circulations were used to establish the desired Pu enrichment. The design of all the fuel rods has been completed incorporating whenever possible the suggestions of the fuel rod vendors. Detailed specifications for mixed pellets and powder have been written. A preliminary measurement program for the critical experiments was formulated. The kinetic characteristics of single zone mixed-oxide (PuO_2–UO_2) critical assemblies were evaluated and a hazards study was made. Author

N67-18969*# Aerojet-General Corp., Azusa, Calif. Von Karman Center.
SNAP-8 MATERIALS REPORT FOR JULY–DECEMBER 1965
H. Derow and B. E. Farwell Feb. 1966 99 p refs
(Contract NAS5-417)
(NASA-CR-72146; Rept.-3134) CFSTI: HC $3.00/MF $0.65
CSCL 18N

Details are given on materials testing to guide in the selection of materials for the components of the SNAP-8 system, whose ultimate objective is the design and development of a 35-kw electrical generating system for use in various space missions. Work in the following areas is reported: test operations support, fabrication support, Stellite 6B evaluation, alternate turbine materials evaluation, evaluation of the -1 boiler, and corrosion loop program. L.E.W.

N67-18985*# Aerojet-General Corp., Azusa, Calif. Von Karman Center.
SNAP-8 MATERIALS REPORT Semiannual Materials Report, Jan.–Jun. 1966
H. Derow and B. E. Farwell Jul. 1966 126 p refs
(Contract NAS5-417)
(NASA-CR-72156; Aerojet-3232) CFSTI: HC $3.00/MF $0.65
CSCL 18N

Investigations were conducted in support of the design, fabrication and development testing of various SNAP-8 components and system loops. Operation of a Hg forced-convection corrosion loop was conducted with the aim of evaluating the corrosion resistance of 9Cr–1Mo alloy steel for 10,000 hour service. Data were developed in a continued program to evaluate the effect of the SNAP-8 turbine operating environment on satellite 6B. Author

N67-19009# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
ALPHA AUTORADIOGRAPHY OF IRRADIATED MATERIALS
J. L. Hascall Oct. 1966 6 p refs
(Contract AT(45-1)-1830)
(BNWL-324) CFSTI: HC $3.00/MF $0.65

Preparation, exposure, processing, and photographic reproduction of pure cellulose nitrate plates are discussed. It is noted that α autoradiography, using cellulose nitrate has many applications in the study of irradiated materials. Such applications include differentiating PuO_2 from UO_2 in mixed oxide fuels, migration studies, α radiation energy studies, and, when used in conjunction with β–γ autoradiography and optical metallography, providing information that might have passed undetected. The preparation and use of the pure cellulose nitrate plate enhances these studies because there are no artifacts or background to detract from the desired information. NSA

N67-19011# Idaho Nuclear Corp., Idaho Falls.
THE TRA SAFEGUARD COMMITTEE
R. J. Nartney Sep. 1966 12 p refs
(Contract AT(10-1)-1230)
(IN-1022) CFSTI: HC $3.00/MF $0.65

The working charter of the TRA Safeguard Committee is presented. It describes the duties and functions of the TRA Safeguard Committee; documents certain existing procedures regarding reactor and experimental safety at the MTR, ETR, and ATR; indicates those activities which require TRA Safeguard Committee approval; describes the procedures for obtaining such approval; and relates the activities of the TRA Safeguard Committee to the functions and responsibilities of Idaho Nuclear Corporation line supervision. Author (NSA)

N67-19062# Atomic Energy Commission, Washington, D. C. Div. of Reactor Development and Technology.
SUMMARIES OF FAST REACTOR FUELS AND MATERIALS DEVELOPMENT PROGRAMS
Edgar C. Norman, ed. May 1966 259 p refs
(TID-6506, Pt. 3, 4th Ed.) CFSTI: HC $3.00/MF $0.65

Research on fuels and materials in support of the Liquid Metal Fast Breeder Reactor Program is summarized. Sections are included on work at Argonne, Atomics International, Battelle, Brookhaven, General Electric, Los Alamos, MSA Research, Monsanto, Nuclear Materials and Equipment Corp., ORNL, United Nuclear Corp., and Westinghouse. NSA

N67-19063# European Atomic Energy Community, Ispra (Italy). Engineering Dept.
EXPERIMENTAL STUDY OF THE STRESS DISTRIBUTION IN THE ESSOR REACTOR VESSEL WALL
P. S. Weltevreden and J. F. G. Blanckenburg 1966 31 p
(EUR-3159.e) CFSTI: HC $3.00/MF $0.65

The ESSOR reactor vessel contains a structural discontinuity in its cylindrical part. This discontinuity will give rise to local stress concentration in the membrane stress-field. For reasons of safety it was required to determine the amount of stress concentration to be expected and to give specifications for the construction of the vessel. This report contains a description of the experimental stress analysis of this discontinuity-stress problem. Its primary scope is to demonstrate, by means of a practical example, the usefulness of the experimental stress analysis techniques regarding safe and economic design of important constructions. In addition it presents a rather detailed view of the various existing techniques and their characteristics. Author

N67-19078* Oak Ridge National Lab., Tenn.
A METHOD OF REPRESENTING TWO-DIMENSIONAL DISTRIBUTIONS FOR USE IN MONTE CARLO CALCULATIONS
M. Leimdorfer and J. Barish Jan. 1967 31 p refs
(NASA Order R-104(1); Contract W-7405-ENG-26)
(NASA-CR-82502; ORNL-4002) CFSTI: HC $3.00/MF $0.65 CSCL 18K

In an attempt to increase the efficiency of an existing Monte Carlo program, the Nucleon Transport Code (NTC), for treating the transport of high-energy nucleons in matter, a method has been developed to improve the procedure for selecting combinations of the energy and angle of particles released in nuclear interactions. In the present form of NTC, the process of particle emission from nucleon–nucleus collisions is simulated by a Monte Carlo treatment of the intranuclear cascade. In the proposed method, the particle emission data obtained from the intranuclear cascade calculations are represented in the form of tables which are suitable for sampling purposes. These tables are constructed directly from the intranuclear cascade (Monte Carlo) histories. Author

N67-19129*# General Dynamics/Fort Worth, Tex.
EVALUATION OF CRYOGENIC INSULATION MATERIALS AND COMPOSITES FOR USE IN NUCLEAR RADIATION ENVIRONMENTS Quarterly Progress Report, 30 Jun.–30 Sep. 1966
E. E. Kerlin 3 Oct. 1966 84 p refs
(Contract NAS8-18024)
(NASA-CR-82450; FZK-319) CFSTI: HC $3.00/MF $0.65 CSCL 18J
(NASA-CR-82450; FZK-319) CFSTI: HC $3.00/MF $0.65

During the first quarter of operation, efforts were directed toward selecting candidate test materials, developing the test plan, and modifying the existing test equipment from a previous contract. Two types of tests are planned for evaluating the radiation dose of 1×10^{11} ergs/gm(C) on materials: (1) mechanical property evaluation of the individual components and combined systems, and (2) functional evaluation of a composite system applied to a test dewar. Author

N67-19145# Battelle Memorial Inst., Columbus, Ohio.
PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING JUNE, 1966
Donald L. Keller 1 Jul. 1966 23 p refs
(Contract W-7405-ENG-92)
(BMI-1778) CFSTI: HC $3.00/MF $0.65

Research results are presented on radiation effects on 347 stainless steel, behavior of interstitial elements on Cr–Y alloys, explosive welding of Zircaloy–Al tubing, thermal stability of Sol–Gel, ThO_2–PuO_2 particles in various atmospheres, development of fuel plates for AARR, room-temperature stability of UN–PuN in O_2 and vacuum, thermal conductivity of irradiated UN, compatibility UN–PuN fuels with 300-series stainless steels, radiation damage in UN–PuN fuels, smoke photometer development, and corrosion of fluoride-volatility process construction materials. NSA

N67-19146# TRW Systems Group, Redondo Beach, Calif.
RADIOISOTOPE PROPULSION TECHNOLOGY PROGRAM (POODLE) Quarterly Progress Report, 1 Jan.–31 Mar. 1966
Apr. 1966 185 p refs
(Contract AT(04-3)-517)
(STL-517-0042) CFSTI: HC $3.00/MF $0.65

Creep of heat source capsules under the action of internal He pressure was studied for operating durations of 30 days at temperatures in the vicinity of 2000°C. Three capsules were made of W-25Re. Oxidation protection must be provided for the refractory alloy capsule structure. Oxidation kinetics and cladding/substrate compatibility were investigated for several Rh–Ir alloys, since these appear to be most promising. Because flow at the POODLE nozzle throat is in the laminar regime, a rapid growth of the boundary takes place in the diverging section. Experimental and analytical tasks are underway to clarify the behavior of low-thrust nozzles and to enable the selection of an optimum design. Further research on heat source simulation is described. NSA

N67-19178# Atomic Energy of Canada, Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment.
THE RADIATION AND THERMAL DECOMPOSITION OF TERPHENYLS AND HYDROTERPHENYLS (A SUMMARY OF CANADIAN EXPERIENCE)
M. Tomlinson, A. W. Boyd, and S. R. Hatcher May 1966 20 p refs Presented at IAEA Panel on the Use of Organic Liquids as Reactor Coolants and Moderators, Vienna, 9–13 May 1966
(AECL-2641) CFSTI: HC $3.00/MF $0.65

At temperatures up to 350°C the radiolytic decomposition of terphenyls: 1) was independent of radiation intensity, 2) increased slightly with temperature, and 3) was several times greater for recoil proton radiation than for fast electrons. Above 350°C the decomposition rate during irradiation: 1) was greater at low intensities than at high intensities, 2) increased more rapidly with

increasing temperature, 3) was independent of the kind of radiation, and 4) increased with increasing radiation pulse frequency. These effects have been interpreted in terms of changes in the radiolytic mechanism at higher temperatures. HB-40, a hydrogenated terphenyl was subjected to prolonged irradiation in a small loop under conditions simulating use in a reactor. Decomposition products were removed by batch distillation and recovered coolant was recycled to attain various stationary compositions. These HB-40 Coolant mixtures differed in important respects from the HB-40 Feed. Rates of consumption of coolant were low, in the range 15 to 20 grams consumed per kWh radiation absorbed, at temperatures in the range 250 to 400°C. Author

N67-19179 European Atomic Energy Community, Ispra (Italy). Reactor Physics Dept.
PLUTHARCO, A PLUTONIUM, URANIUM, THORIUM ASSEMBLY REACTIVITY CODE: PHYSICAL CONCEPTS, COMPARISONS WITH EXPERIMENTS AND CODE DESCRIPTION
W. De Haan and R. Mosthuysen 1966 127 p refs
(EUR-3141.e) CFSTI: $3.00

In the framework of the Orgel reactor physics development program, a new method for heavy water lattice calculations has been established. This method is intended for design survey type calculations and for preliminary fuel cycle analysis. Lattices fueled with uranium, thorium and plutonium can be investigated. The method is based on the four factor formula, the two group theory and the Westcott cross-section formalism. The method has been written in Fortran II for the IBM-7090 computer, with the name PLUTHARCO (PLutonium, Uranium, THorium Assembly Reactivity COde). The code gives directly with the results the input data for RLT-4 burn-up calculations. Author

N67-19187 Osterreichische Studiengesellschaft fur Atomenergie G.m.b.H., Seibersdorf (Austria). Institut fuer Chemie.
THE USE OF FLUOROCARBONS FOR CHEMICAL DOSIMETRY IN NUCLEAR REACTOR RADIATION FIELDS [DIE VERWENDUNG VON FLUORKOHLENSTOFFEN ZUR CHEMISCHEN DOSIMETRIE IM KERNREAKTORSTRAHLUNGSFELD]
E. Prokesch and E. Slais 1966 9 p refs In GERMAN; ENGLISH summary Presented at 3d Intern. Congr. of Radiation Res., Cortina d'Ampezzo, Italy, 30 Jun. 1966 Submitted for Publication
(SGAE-CH-40/1966) CFSTI: $3.00

The formation of CF_4 from suitable fluorocarbons combined with the hydrogen produced from cyclohexane is proposed as a method for the simultaneous determination of gamma and fast neutron doses. Both measurements may be easily performed by gas chromatography. As examples, two commercial perfluorokerosene mixtures were investigated. After purification, both mixtures show $G(CF_4)$ values which are sufficiently reproducible and but slightly dependent on dose. When used for in-pile dosimetry satisfactory agreement was found with calorimetry. Author

N67-19194* Societa Nazionale Metanodotti, Milan (Italy). Laboratori Riuniti Studi e Ricerche.
MEASUREMENT THE INFINITE MULTIPLICATION CONSTANT OF NATURAL URANIUM/GRAPHITE LATTICES IN THE RB-1 CRITICAL ASSEMBLY BY MEANS OF THE ZERO REACTIVITY METHOD [MISURA DELLA COSTANTE DI MOLTIPLICAZIONE INFINITA DI RETICOLI A URANIO NATURALE E GRAFITE NELL'INSIEME CRITICO RB-1 CON IL METODO DELLA REATTIVITA'NULLA]
G. Ghillardotti Brussels, EURATOM, Oct. 1966 231 p refs In ITALIAN; ENGLISH Summary
(Contract EURATOM-038-64-3 TEGI)
(EUR-3126.i) CFSTI: $3.00

A consistent and complete experimental procedure was devised for measuring the K_∞ of natural uranium/graphite lattices by means of the zero reactivity method. The same applies to the procedure for analysis of the experimental data. The error in $(K_\infty-1)$ inherent in measurement can in our opinion be reduced to 2%. This limit was reached in the last experiment on lattices consisting of tubular elements. Agreement proved to be good with the results obtained by the CEA in the critical assembly MARIUS. Author

N67-19200 Osterreichische Studiengesellschaft fur Atomenergie G.m.b.H., Seibersdorf (Austria).
FUEL CONSUMPTION INDEX FOR REACTORS AND REACTOR SYSTEMS [BRENNSTOFF-VERBRAUCHSKENNZIFFERN FUER REAKTOREN UND REAKTORSYSTEME]
H. Gruemm 1966 17 p refs In GERMAN Submitted for Publication
(SGAE-RE-5/1966) CFSTI: $3.00

Discussed is a method for standardizing calculations of the fuel requirements of single power reactors and reactor systems. Parameters affecting fuel consumption are expressed in form of an index. Reactor power output, fuel inventory, and regeneration of fuel elements are taken into account. Transl. by K.W.

N67-19201 Aktiebolaget Atomenergi, Stockholm (Sweden).
THE DANCOFF CORRECTION IN SQUARE AND HEXAGONAL LATTICES
I. Carlvik Nov. 1966 38 p refs
(AE-257) CFSTI: HC $3.00

Results of a series of calculations of Dancoff corrections for square and hexagonal rod lattices are reported. Presented are tables which cover a wide range of volume ratios and moderator cross sections. Results were utilized for checking the approximative formula of Sauer and also the modification of Bonalumi to Sauer's formula. The modified formula calculates the Dancoff correction with an accuracy of 0.01–0.02 in cases of practical interest Calculations were performed on square lattices with an empty gap surrounding the rods. Results demonstrate the error involved in treating this kind of geometry by means of homogenizing the gap and the moderator. Initial calculations were made on the Ferranti Mercury computer; however, since then Fortran routines for Dancoff corrections have been written, and a subroutine DASOHE is included in the report. Author

N67-19248* Atomic Energy of Canada, Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment.
SOME ASPECTS OF MATERIALS IN ORGANIC COOLED REACTORS (A SUMMARY OF CANADIAN EXPERIENCE)
J. Boulton May 1966 15 p refs Presented at IAEA Panel on the use of Organic Liquids as Reactor Coolants and Moderators, Vienna, 9–13 May 1966
(AECL-2640) CFSTI: HC $3.00/MF $0.65

The results of development work on the use of SAP and zirconium alloys in organic coolants are summarized. Most attention is given to the behavior of zirconium alloys since these are at present being used for fuel cladding and pressure tubes in the WR-1 organic cooled reactor. The operating life of zirconium alloys as a fuel cladding and pressure tube material is discussed and future developments which may extend the useful life of these alloys indicated. Some brief comments are made on stress corrosion cracking of stainless steel in chlorine contaminated coolant. Author

N67-19250* Canadian Westinghouse Co., Ltd., Port Hope (Ontario). Atomic Fuel Dept.
RESISTANCE WELDING OF ZIRCALOY END CLOSURE JOINTS

K. T. Bates Oct. 1966 16 p ref Paper No. 2/6 presented at NUCLEX 66 Intern. Nucl. Ind. Fair and Tech. Meetings, Basel, 8–14 Sep. 1966 Sponsored by Atomic Energy of Canada, Ltd.
(AECL-2814) CFSTI: HC $3.00/MF $0.65

The resistance welding of Zircaloy has been adopted by fabricators to produce low cost, high quality fuel on a production scale. A process for resistance welding end closure joints of tubular fuel elements is described. An outline of the process development is given together with description of present day production methods, an assessment of quality, and irradiation experience. Author

N67-19254# Canadian Westinghouse Co., Ltd., Port Hope (Ontario). Atomic Fuel Dept.
BRAZING OF ZIRCALOY IN NUCLEAR FUEL
K. T. Bates Sep. 1966 17 p refs Paper No. 2/5 presented at NUCLEX 66 Intern. Nucl. Ind. Fair and Tech. Meetings, Basel, 8–14 Sep. 1966 Sponsored by Atomic Energy of Canada, Ltd.
(AECL-2813) CFSTI: HC $3.00/MF $0.65

A braze alloy (Zr+5 wt% Be) is being used for the fabrication of Zircaloy clad fuel. Development of the process and some of the problems which were overcome are described. Present day manufacturing techniques, corrosion data and irradiation experience are presented. Author

N67-19256# Atomic Energy of Canada, Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment.
THERMAL DIFFUSION OF HYDROGEN IN FINNED ZIRCALOY-2 PRESSURE TUBES
B. J. S. Wilkins and A. Sawatzky Oct. 1966 17 p refs
(AECL-2634) CFSTI: HC $3.00/MF $0.65

The mechanical properties of zirconium alloy pressure tubes may be seriously impaired by the absorption of hydrogen from the reactor environment. This would lead to an unacceptable restriction of their service life. A new approach to the problem, exploiting the phenomenon of thermal diffusion, is described. It has been demonstrated that hydrogen (hydride) may be moved, by a maintained thermal gradient, from a Zircaloy-2 pressure tube into an attached Zircaloy-2 sink. The sink consisted of fins welded along the tube length. Author

N67-19260 Reactor Group, United Kingdom Atomic Energy Authority, Culcheth (England).
WINDSCALE A.G.R. GRAPHITE DAMAGE FLUX CALIBRATION EXPERIMENT
R. P. Thorne and V. C. Howard 1966 46 p refs
(TRG-1267(C)) CFSTI: $3.00

During the approach to full power the graphite damage flux was experimentally determined in a number of facilities in the advanced gas-cooled reactor. The experimental data are compared with the predictions of both an empirical approach and a theoretical computation. Author

N67-19261# Atomic Energy of Canada, Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment.
COMPOSITION AND PHYSICAL PROPERTIES OF ORGANIC COOLANTS (A SUMMARY OF CANADIAN DATA AND USE)
S. R. Hatcher and M. Tomlinson May 1966 26 p refs Presented at the Intern. Atomic Energy Agency Panel on the Use of Org. Liquids as Reactor Coolants and Moderators, Vienna, 9–13 May 1966
(AECL-2644) CSCL: HC $3.00/MF $0.65

Physical property data are summarized for organic coolant mixtures formed from the terphenyl feed mixture, Santowax OM, and from the hydrogenated terphenyl feed mixture HB-40. Particular attention was given to the coolant mixtures of stationary composition, including about 30% high boiler decomposition products, formed by prolonged use under reactor conditions. Properties depended to some extent on the manner of operation of the system. Author

N67-19321# Oak Ridge National Lab., Tenn.
NEUTRON PHYSICS DIVISION Annual Progress Report, Period Ending May 31, 1966
Sep. 1966 81 p refs
(Contract W-7405-ENG-26)
(ORNL-3973, Vol. I) CFSTI: HC $3.00/MF $0.65

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4. RADIATION SHIELDING INFORMATION CENTER p 48–51 refs (See N67-19325 08-22)
5. MATHEMATICS AND COMPUTER PROGRAMS p 52–59 refs (See N67-19326 08-22)
6. RADIATION DETECTOR STUDIES (I) p 60–68 refs (See N67-19327 08-14)

N67-19323# Oak Ridge National Lab., Tenn.
CRITICAL EXPERIMENTS
In its Neutron Phys. Div. Sep. 1966 p 14–25 refs (See N67-19321 08-22) CFSTI: HC $3.00/MF $0.65

Criticality studies were made for a stainless-steel sphere containing UO_2F_2 solution with a ^{235}U content of 4.98%. Experiments were performed to determine the critical parameters of lattices of cylindrical annuli of uranium enriched to 1.95% in ^{235}U moderated and reflected by water. A comparison was made with experimental results of the values of k_{∞} of various hydrogen-moderated assemblies of uranium of low enrichment calculated by the 05R Monte Carlo code. Prompt-neutron decay constants were measured by the Rossi-α technique in subcritical 7-, 11-, and 15-in. diameter cylinders of enriched uranium metal (93.15% ^{235}U) of heights varying in 0.12-in. decrements from slightly subcritical to half critical. Using the measured values of β/l for delayed critical cylinders of the same diameter and calculated changed in β/l due to the decrease in height, multiplication factors were obtained. The time dependence of fission events in a subcritical assembly consisting of two coaxial 11-in.-diameter uranium (93.2% ^{235}U; $\rho = 1.87$ g/cm^3) metal cylinders 2.625 in. thick separated by 14.55 in. was measured by the Rossi-α technique. Critical experiments are reported which were performed in support of the design of the Sorgente Rapida (SORA) fast, NaK-cooled, pulsed neutron-source reactor. Experimental data is presented for criticality of arrays of enriched uranium cylinders for use in safe storage and transport of fissile materials. Results are given for a series of experiments on the critical parameters of lattices of Heat Transfer Reactor Experiment fuel elements, primarily in geometries and environments of interest for transport, storage, and chemical dissolution. NSA

N67-19324# Oak Ridge National Lab., Tenn.
REACTOR AND WEAPONS SHIELDING
In its Neutron Phys. Div. Sep. 1966 p 26–47 refs (See N67-19321 08-22) CFSTI: HC $3.00/MF $0.65

Thermal-neutron fluxes reflected from concrete were measured as a function of angles of incidence and reflection for incident epicadmium neutrons. Calculations of the differential angular albedo of subcadmium neutrons arising from incident monodirectional beams of epicadmium neutrons on concrete were made and were compared with experiment. Measurements were made of the thermal-neutron flux and fast-neutron dose rate down rectangular concrete ducts with one and two bends. Calculations were made

of thermal-neutron fluxes and fast-neutron dose distributions in one-, two-, and three-legged rectangular concrete ducts, and were compared with experiment. Experiments were made to measure the fast-neutron dose rate transmitted through a LiH shield with an iron-oil collar shield, designed for use with SNAP power plants. To aid in the design of a specific collimator for the SNAP core-mapping experiments, a series of Monte Carlo calculations using the 05R code were made to determine the effect of the collimator geometry on the ratio of neutrons that arrive directly at the detector to neutrons that are scattered or transmitted by the walls of the collimator shield. The transport of neutrons from point isotropic fission and 14-MeV sources in an infinite air medium was calculated by the Monte Carlo 05R code and by the ANISN discrete-ordinate code. Progress in discrete-ordinate transport theory and applications to shielding problems are reported. NSA

N67-19325# Oak Ridge National Lab., Tenn.
RADIATION SHIELDING INFORMATION CENTER
In its Neutron Phys. Div. Sep. 1966 p 48–51 refs (See N67-19321 08-22) CFSTI: HC$3.00/MF$0.65

A brief review is given of the programs being carried out by the Radiation Shielding Information Center (RSIC). These programs include literature reviews on reactor and weapons shielding, space and accelerator shielding, and computer codes for shielding calculations. NSA

N67-19326# Oak Ridge National Lab., Tenn.
MATHEMATICS AND COMPUTER PROGRAMS
In its Neutron Phys. Div. Sep. 1966 p 52–59 refs (See N67-19321 08-22) CFSTI: HC$3.00/MF$0.65

Brief summaries are given of some work in mathematics and computer programs. These include shielding design calculations for fuel-handling facilities; computer calculations of γ-ray transport and dose rates; Monte Carlo calculations; the 05R program for neutron transport; random number generators for the IBM 360; CDC 160-A programs for processing data from neutron time-of-flight cross-section measurements; a program to calculate Legendre coefficients from angular distributions; and impossible Legendre coefficients. NSA

N67-19330# Battelle-Northwest, Richland, Wash.
CERAMICS RESEARCH AND DEVELOPMENT Quarterly Report, Oct.–Dec. 1965
Dec. 1965 131 p refs
(Contract AT(45-1)-1830)
(BNWL-269) CFSTI: HC$3.00/MF$0.65

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4. JOINT FUEL DEVELOPMENT PROGRAMS 9 p refs (See N67-19334 08-22)
5. DEVELOPMENT OF ADVANCED FUEL CONCEPTS 36 p (See N67-19335 08-22)

N67-19331# Battelle-Northwest, Richland, Wash.
CERAMIC FUEL RESEARCH STUDIES
In its Ceram. Res. and Develop. Dec. 1965 28 p refs (See N67-19331 08-22) CFSTI: HC$3.00/MF$0.65

Ceramic fuel researches cover measurements of thermal diffusivity of MTR-ETR type fuel-plates, electrical conductivity of uranium oxide, thermal conductivity of $LiAlO_2$, stoichiometry gradients in oxide fuels, work function of high purity polycrystalline tantalum, thermal expansion of plutonium fuels, and crush strengths for some small diameter ceramic fuel particles. Phase studies for plutonium oxide and actinide oxide oxide are noted, and high frequency induction heating of oxides by a ThO_2 susceptor furnace is described. Other studies in ceramic fuels research deal with substoichiometric mixed oxides of plutonium and uranium, a differential thermal analysis apparatus, and a refractory compounds research facility. Specifications for the physical and chemical properties for nuclear fast reactor grade mixed oxides, are mentioned and materials and information exchange is considered. Separate reports are included for each of the studies. M.W.R.

N67-19332# Battelle-Northwest, Richland, Wash.
IRRADIATION BEHAVIOR OF CERAMIC FUELS
In its Ceram. Res. and Develop. Dec. 1965 11 p ref (See N67-19331 08-22) CFSTI: HC$3.00/MF$0.65

Irradiation performance of fast reactor fuel candidates, plutonium ceramics irradiations, and testing of a defective fuel rod operating with a molten core are considered in studies of the irradiation behavior of ceramic fuels. In the fuel candidates study, significant plutonium redistribution occurred during irradiation of the UN-20 wt% PuN fuel (GEH-14-1616) at 2.4×10^{20} f/cm^3. Separate reports are included for each of the studies. M.W.R.

N67-19333# Battelle-Northwest, Richland, Wash.
PRTR FUEL ELEMENT PERFORMANCE AND FABRICATION
In its Ceram. Res. and Develop. Dec. 1965 30 p refs (See N67-19331 08-22) CFSTI: HC$3.00/MF$0.65

High pressure mash-spot resistance welding encapsulation for use on TREAT (Transient Reactor Test) capsules, TREAT irradiations of the PRTR (Plutonium Recycle Test Reactor) high power density core experiment, and other aspects of PRTR fuel element performance and fabrication are considered in a series of reports. Fuel element internal gas pressure measurements, thermal cycling of defective cladding of Zircaloy tubing and molten-core fuel capsule testing are reported. Other studies deal with high power density fuel element irradiations in the PRTR, zirconium hydride in PRTR fuel rods that failed, and quality control for PRTR fuels. Building addition and facilities modifications research are noted. M.W.R.

N67-19334# Battelle-Northwest, Richland, Wash.
JOINT FUEL DEVELOPMENT PROGRAMS
In its Ceram. Res. and Develop. Dec. 1965 9 p refs (See N67-19331 08-22) CFSTI: HC$3.00/MF$0.65

Progress is reported for reactor fuel development programs dealing with (1) irradiation testing of EBWR (Experimental Breeder Water Reactor) prototype fuel rods, (2) sintered aluminum powder end closures, (3) fabrication of critical plates for irradiation in the MTR (Materials Testing Reactor) to test the Phoenix fuel concept, (4) and ultrasonic examination of Saxton tubing subjected to thermal cycling. In the EBWR study, three capsules that are still under irradiation have achieved a maximum burnup of 20,050 MWd/MT of fuel (5×10^{20} fissions/cm^3. Flux-wire data and isotopic analysis results indicate that fuel burnup was underestimated in previous studies. M.W.R.

N67-19335# Battelle-Northwest, Richland, Wash.
DEVELOPMENT OF ADVANCED FUEL CONCEPTS
In its Ceram. Res. and Develop. Dec. 1965 36 p (See N67-19331 08-22) CFSTI: HC$3.00/MF$0.65

Material and processes are investigated for the development of advanced fuel concepts. Thick walled tantalum tube was joined by magnetic force welding, and the tungsten-inert gas process was investigated for welds on four metals. Other studies deal with

spheroidization of UO_2-PuO_2 and PuO_2, coining of cermet extrusion billets and evaluation of cermet fuel pins, pressure measurements of UO_2 capsules at elevated temperatures, and pneumatic impaction of tungsten powders. A number of fiber-reinforced metal matrix composities were studied for strengthening fuel core and cladding elements. Significant increases in both yield and ultimate tensile strengths were obtained in continuous axially aligned fiber reinforced nickel composites, and single crystal aluminum oxide and silicon carbide whisker reinforcements are being studied. Chopped randomly oriented tungsten fibers did not significantly improve the mechanical properties of metal matrix composites. Separate reports are included for each of the studies. M.W.R.

23 PHYSICS, GENERAL

Includes acoustics, cryogenics, mechanics, and optics. For astrophysics see: 30 Space Sciences. For geophysics and related information see also: 13 Geophysics; 20 Meteorology; and 29 Space Radiation.

N67-18289# Northrop Corp., Newbury Park, Calif. Applied Research Dept.

PULSES IN LINEAR ACOUSTICS

K. M. Mitzner Nov. 1966 221 p refs

(Contract Nonr-4802(00))

(ARD-66-60-R; AD-643330) CFSTI: HC $3.00/MF $0.65

The wave equation is solved for general geometries and boundary conditions by two methods. The problem is reduced to the frequency domain and is solved using an integral equation formulation appropriate to the given boundary condition. The retarded potential integral equation is applied to objects with the rigid boundary condition. Where possible, numerical results are compared with experiment, eigenfunction expansions, and approximate solutions. Author (TAB)

N67-18310*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

A NOTE ON NULL GEODESICS IN THE GENERAL THEORY OF RELATIVITY

H. Lass *In its* Space Programs Sum. No. 37-42, Vol. IV 31 Dec. 1966 p 30-31 (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

The Schwarzchild line element for a spherically symmetrical mass, M, is given by

$$ds^2 = c^2\left(1 - \frac{2GM}{c^2r}\right)dt^2 - \frac{dr^2}{1 - \frac{2GM}{c^2r}} - r^2(d\theta^2 + r^2\sin^2\theta\, d\phi^2)$$

for the region external to the mass. For planar motion, $\theta = \pi/2$, it is known that the geodesics obtained from $\delta\int ds = 0$ yield

$$\frac{d^2u}{d\phi^2} + u = \frac{GM}{h^2} \quad \frac{3GM}{c^2}\,u^2$$

$$r^2\,\frac{d\phi}{ds} = h$$

with $u = 1/r$, and h a constant of the motion. The motion of light is such that $ds = 0$, which yields $h = \infty$ from

$$r^2\,\frac{d\phi}{ds} = h,$$

so that

$$\frac{d^2u}{d\phi^2} + u = \frac{GM}{h^2} + \frac{3GM}{c^2}\,u^2$$

becomes

$$\frac{d^2u}{d\phi^2} + u = \frac{3GM}{c^2}\,u^2$$

yielding a slight variation from the linear paths in the absence of gravitational masses. Since equations

$$\frac{d^2u}{d\phi^2} + u = \frac{GM}{h^2} + \frac{3GM}{c^2}\,u^2$$

and

$$r^2\,\frac{d\phi}{ds} = h$$

are derived on the premise that $ds \neq 0$, it is difficult to follow how one can justify setting $ds = 0$ to obtain $h = \infty$, and to conclude that the angular momentum of light is infinite. Equation

$$\frac{d^2u}{d\phi^2} + u = \frac{3GM}{c^2}\,u^2$$

is obtained by positing that $ds = 0$ and that the coordinate time, t, is extremalized for light paths, namely $\delta\int dt = 0$. It is surmised that this derivation seems more satisfactory than the classical approach of setting $h = \infty$. It can be shown also that the light paths are invariant under the set of transformations $t = t,x = x(\bar{x},\bar{y},\bar{z}),y = y(\bar{x},\bar{y},\bar{z})z = z(\bar{x},\bar{y},\bar{z})$, for any static line element. S.C.W.

N67-18462# California Univ., Livermore. Lawrence Radiation Lab.

ELECTRICAL PROPERTIES OF DIELECTRIC LIQUIDS IN A RADIATION FIELD

Don S. Slack 15 Sep. 1966 11 p refs Presented at the Symp. on Eng. Probl. of Controlled Thermonucl. Res., Gatlinburg, Tenn., 3-6 Oct. 1966 Submitted for Publication

(Contract W-7405-ENG-48)

(UCRL-70022; CONF-661018-14) CFSTI: HC $3.00/MF $0.65

Experiments were conducted to determine changes, transient and permanent, in the electrical properties of various liquids when irradiated. The liquids tested were irradiated using the Astron accelerator beam pulse intensities of 3.3×10^7 R/sec and doses of 2 to 5×10^5 R/sec and a Ta target to provide bremsstrahlung. The materials studied included: perfluorocyclicbutylamines, trichlorotrifluoroethane, trichloropentafluoropropane, chlorotrifluoroethylene, various petroleum products, a synthetic hydrocarbon, and a pure fluorocarbon. Conductivity increased during and a short time after the pulse. Transient conductivity of all liquids tested behaved similarly, and varied less than an order of magnitude. Maximum transient conductivity increase was about 2×10^{-10} mho-cm. Breakdown voltage was not greatly reduced by permanent radiation damage at the doses used, nor by the transient effects of the pulsed radiation used. NSA

N67-18493 Joint Publications Research Service, Washington, D. C.

TRANSLATIONS ON COMMUNIST CHINA: SCIENCE AND TECHNOLOGY, NUMBER 364

14 Dec. 1966 26 p refs
(JPRS-39107; TT-66-35530) CFSTI: $3.00

CONTENTS:

1. AN ANECHOIC WATER TANK FOR HIGH FREQUENCIES W.-i. Hsu p 1–6 refs (See N67-18494 08-11)
2. ORTHOGONAL WAVE FUNCTIONS OF A STRATIFIED MEDIUM J.-h. Chang p 7–11 refs (See N67-18495 08-23)
3. THE NORMAL MODE SOUND FIELD IN SHALLOW WATER WITH NEGATIVE GRADIENT J.-h. Chang p 12–21 refs (See N67-18496 08-23)

N67-18495 Joint Publications Research Service, Washington, D. C.

ORTHOGONAL WAVE FUNCTIONS OF A STRATIFIED MEDIUM

Jen-ho Chang *In its* Transl. on Communist China: Sci. and Technol., No. 354 14 Dec. 1966 p 7–11 refs Transl. into ENGLISH from Sheng-Hsueh Hsueh-Pao (Peking), v. 2, no. 2, Jun. 1965 p 102–103 (See N67-18493 08-23) CFSTI: $3.00

The sound field of a stratified medium is described by a physical quantity, which is related to the acoustic pressure and the particle velocity. An equation is given for orthogonal wave functions, and the method for solving the boundary conditions by separation of variables is shown. The case of homogeneous shallow water is used to show how these computations are performed, and wave functions of continuous eigenvalues are obtained. M.W.R.

N67-18496 Joint Publications Research Service, Washington, D. C.

THE NORMAL MODE SOUND FIELD IN SHALLOW WATER WITH NEGATIVE GRADIENT

Jen-ho Chang *In its* Transl. on Communist China: Sci. and Technol., No. 354 14 Dec. 1966 p 12–21 refs Transl. into ENGLISH from Sheng-Hsueh Hsueh-Pao (Peking), v. 2, no. 1, Mar. 1965 p 24–28 (See N67-18493 08-23) CFSTI: $3.00

The sound field is discussed for a harmonic point source in shallow water with a negative gradient. Since it is assumed that the sound velocity in sea water is a slowly varying function the decreases monotonically with depth, it is not considered necessary to give a concrete functional form for the sound field. Pole equations for normal mode waves and an approximate expression of the amplitude function are derived that provide numerical solutions for group velocity of normal mode waves and the exponential attenuation coefficient. Author

N67-18512 Joint Publications Research Service, Washington, D. C.

THE THEORY AND MEASUREMENT OF AN ELECTROMAGNETIC IMPULSE SOUND-SOURCE

Ch'un-k'uei Liu, Shu-ying Chang, and Hung-lieh Ling *In its* Transl. on Communist China's Sci. and Technol., No. 356 20 Dec. 1966 p 1–15 refs (See N67-18511 08-34) CFSTI: $3.00

A functional analysis is presented on an electromagnetic impulse sound source, which is capable of radiating high power, wideband sound pulsations with good repetition. Formulas for designing the device are derived. A flat pancake coil, a movable metal plate, and a set of capacitance energy stores are the primary engineering design features. The circuit is primarily composed to three fundamental units of high tension energy storing voltage, a triggering discharge switch, and an electromagnetic energy converter. The characteristics of the electromagnetic pulse sound source were measured in a water pool; the experimental results were found to agree with the theory. M.G.J.

N67-18515 Joint Publications Research Service, Washington, D. C.

SPACE-TIME CORRELATION FUNCTION OF A NOISE-FIELD

Cheng-yung Hsu *In its* Transl. on Communist China's Sci. and Technol., No. 356 20 Dec. 1966 p 42–54 refs (See N67-18511 08-34) CFSTI: $3.00

Studies on noise sources in space and the characteristics of the time–space correlation function of the noise field were extended by deriving differential equations to satisfy the noise field in the space containing the noise sources and the time–space correlation function. The given conditions are various hydrological conditions of the time–space correlation function of the noise field, the equation of the boundary conditions, and the time–space characteristics of the noise sources. Some particular cases were calculated for the time–space correlation function of the noise field. Author

N67-18518*# Alabama Univ., University. Bureau of Engineering Research.

AN EXPERIMENTAL STUDY OF MOLECULAR SURFACE INTERACTIONS AT VELOCITIES UP TO AND EXCEEDING SPACE PROBE ESCAPE VELOCITIES Final Report

Walter J. Schaetzle 15 Jun. 1966 109 p refs
(Contract NAS8-5326)
(NASA-CR-82092) CFSTI: HC $3.00/MF $0.65 CSCL 13K

The instrumentation to provide accommodation coefficient data is described, and the data obtained are discussed. The tankage system and the titanium and diffusion pumping system configurations are presented. The design of a swinging pendulum and a rotational torsional pendulum force probe are reported. Details are given on the free molecular flow nozzle system to form a low velocity molecular beam. The ion acceleration, focusing, and neutralization for the molecular accelerator are described. An analysis of the accommodation coefficient is presented, and data is discussed for plastic and brass probes. It was found that: (1) The swinging plastic probe gave normal coefficients of 0.99 to 1.00 between angles of 90° to 20°. (2) The rotating plastic probe gave a slight variation from the normal coefficients. (3) The brass probe deflections turned out to be slightly higher than predicted. (4) The tangential probe gave too much scatter for reliable results. N.E.N.

N67-18612# Sandia Corp., Albuquerque, N. Mex.

ATTENTION OF A PLANE-WAVE ELECTROMAGNETIC FIELD BY AN IMPERFECTLY CONDUCTING PROLATE SPHEROIDAL SHELL

Clayborne D. Taylor and Charles W. Harrison, Jr. Oct. 1966 13 p refs
(Contract AT(29-1)-789)
(SC-R-66-966) CFSTI: HC $3.00/MF $0.65

The shielding ratio, under quasi-static conditions, is determined for an imperfectly conducting prolate spheroidal shell, when the electric field of the incident plane wave is directed parallel to the major axis of the spheroid. General expressions are obtained for the fields within the cavity. It is shown that the shielding ratio of a spheroid having an eccentricity approaching unity is the same as that of the "corresponding" end-capped cylinder. Author (NSA)

N67-18651* Wisconsin Univ., Madison. Theoretical Chemistry Inst.

THE QUANTUM MECHANICAL KINETIC THEORY OF LOADED SPHERES

John J. Mueller 25 Oct. 1965 63 p refs
(Grant NsG-275)
(NASA-CR-68702; WIS-TCI-131) CFSTI: $3.00 CSCL 20J

The transport coefficients of a gas of loaded spheres, that is, spheres in which the center of mass does not coincide with

the geometrical center are considered. The amount by which the center of mass is displaced from the center of the sphere is denoted by δ and the diameter of the sphere is σ. The scattering amplitude and cross section are found as power series in δ/σ; the coefficients of the zero, first, and second power of δ/σ are obtained. Using these results, the quantum mechanical expressions for the relaxation time, coefficient of shear viscosity, and coefficient of thermal conductivity are also obtained explicitly to second order in δ/σ. These quantities are then evaluated, numerically, in the limit that Planck's constant approaches zero. The results are found to agree with results obtained by purely classical methods. Author

N67-18658*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

KIRCHHOFF'S THEOREM IN THE ACOUSTICS OF A MOVING MEDIUM

L. A. Chernov Redstone Arsenal, Ala., Redstone Sci. Inform. Center, Jan. 1967 29 p refs Transl. into ENGLISH from Tr. Komis. po Akustike, Akad. Nauk SSSR (Moscow), v. 5, 1950 p 10–22 Jointly supported by Army Missile Command
(NASA-TM-X-59396; RSIC-628) CFSTI: HC $3.00/MF $0.65 CSCL 20A

Kirchhoff's theorem is finding diverse applications in acoustics and optics. Its generalization for the case of a moving medium has been given for an examination of a uniform flow. This paper presents a further generalization of this theorem for the case of a potential movement of a medium. The application of the theorem is illustrated with the solution of a problem on the point source of sound, which is in the flow. Author

N67-18677 France. Office National D'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.

APPLICATION OF CORPUSCULAR OPTICS TO THE STUDY OF MATERIALS [APPLICATION DE L'OPTIQUE CORPUSCULAIRE AUX ETUDES SUR LES MATERIAUX]

R. Castaing *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 29–30 (See N67-18661 08-34) CFSTI: $3.00

This conference excerpt reports the electron microscopy method, and electron and corpuscular optics advancements in materials research. Ion bombardment and magnetic scattering techniques for improved image resolution are stressed. In a similar arrangement used with the electron miscroscope, the characteristic energy loss is utilized for improved image formation. Transl. by R.Ll.

N67-18768*# Republic Aviation Div., Fairchild Hiller Corp., Farmingdale, N. Y.

DEVELOPMENT OF MAGNETIC COILS FOR CONTINUOUS USE AND A COIL-POSITIONING AND TRANSPORTER DOLLY Final Report, Jun. 1964–Feb. 1966

F. J. Hoppe 10 May 1966 68 p
(Contract NAS8-11735)
(NASA-CR-82158; FHR-3258) CFSTI: HC $3.00/MF $0.65 CSCL 20C

Water-cooled magnetic coils for capacitive discharge service of various diameters have now been developed. These are capable of continuous operation at 15,000-joule energy levels and at the repetition rate of one discharge every 10 seconds. A mobile coil positioning dolly has also been designed and manufactured. Author

N67-18968*# Perkin-Elmer Corp., Norwalk, Conn. Electro-Optical Group.

ACTIVE OPTICAL SYSTEM FOR SPACEBORNE TELESCOPES Final Report

R. A. Arnold, R. Crane, R. J. Fowski, E. C. Gaal, R. C. Liu et al 14 Oct. 1966 78 p ref
(Contract NAS1-5198; Proj. SPO 26940)
(NASA-CR-66297; Rept.-8525) CFSTI: HC $3.00/MF $0.65 CSCL 20F

The fundamental concept of active optics is to measure the surface shape of a telescope primary mirror, compute the necessary electronic control signals, and physically aline the mirror to its original design figure. This experiment consisted of measuring and correcting the alinement of the three segments of a twenty inch spherical mirror to 1/20 of the wavelength of light (6328Å). Author

N67-18976*# Kansas State Univ., Manhattan. Dept. of Electrical Engineering.

BACKSCATTER OF ULTRASONIC WAVES FROM A ROUGH LAYER

Wu-Shi Shung, W. W. Koepsel, and S. H. Durrani May 1966 74 p refs
(Contract NSR-17-004-003; Grant NsG-692)
(NASA-CR-82399; EE-TR-4) CFSTI: HC $3.00/MF $0.65 CSCL 20A

The backscatter from a rough surface is usually calculated by using Kirchhoff's approximation. In this report, the Kirchhoff's approximation is extended to the backscattering of an acoustic wave from a rough layer. The random rough interface of the layer is assumed to have one-dimensional Gaussian distributed surface heights. Gaussian and exponential autocorrelation functions are used to represent the correlation of the heights at two different points. Expressions for the variance of the scattering coefficient are derived in the case that the rough side is very rough. Experimental investigations were conducted at ultrasonic frequencies on a target designed to have Gaussian distribution and correlation. The measured variance of the scattering coefficient ρ, $D[\rho]$, has the following properties: (A) $D[\rho]$ is highly frequency dependent; it decreases as the frequency increases. (B) $D[\rho]$ decreases more rapidly than that obtained from a rough surface. (C) The dependence of $D[\rho]$ on the incidence angle θ_1 is such that it increases as θ_1 increases, if θ_1 is small. The experimental results lie between the theoretical results calculated for two kinds of correlation. This agrees with the measured value of the correlation function of the target. Author

N67-19075*# IIT Research Inst., Chicago, Ill.

INVESTIGATION OF LIGHT SCATTERING IN HIGHLY REFLECTING PIGMENTED COATINGS. VOLUME 2: CLASSICAL INVESTIGATIONS; THEORETICAL AND EXPERIMENTAL Final Report, 1 May–30 Sep. 1966

G. A. Zerlaut, S. Katz, V. Raziunas, and M. Jackson Oct. 1966 107 p refs
(Contract NASr-65(07); IITRI Proj. U6003)
(NASA-CR-61166; IITRI-U6003-19, Vol. 2) CFSTI: HC $3.00/MF $0.65 CSCL 20F

Light scattering theory is applied to particle arrays in order to explain the scattering behavior of highly reflecting and other polydisperse pigmented coatings. A review of classical theory considers the concept of light scattering by particles, and multiple theoretical films of spherical particles of both infinite and real refractive index. Experimental studies of silver bromide dispersion are described, including secondary oscillations in scattering by polystyrene spheres, suspensions with two particle sizes, and optical properties of films and flocculated dispersions. A multilayer model of paint film is verified, and the optical properties of mixed powders are characterized. M.W.R.

N67-19078*# IIT Research Inst., Chicago, Ill.
INVESTIGATION OF LIGHT SCATTERING IN HIGHLY REFLECTING PIGMENTED COATINGS. VOLUME 3: MONTE CARLO AND OTHER STATISTICAL INVESTIGATIONS
B. H. Kaye, M. Jackson, and G. A. Zerlaut Nov. 1966 208 p refs
(Contract NASr-65(07); IITRI Proj. U6003)
(NASA-CR-61187; IITRI-U6003-19, Vol. 3) CFSTI: HC $3.00/MF $0.65 CSCL 20F

The relevance of Mie theory for predicting reflective properties of paint films and semantic problems in studying these reflective properties are considered. The latter deals with specification of pigment size, the concept of randomness, diffuse light, boundary conditions of paint films, and size distribution of pigment particles dispersed in paint films. Measurement of shape and simulation of packing of pigment particles are treated, as is the use of Monte Carlo methods in paint technology. Monte Carlo studies are made of growth in scattering centers at various concentrations of pigment. A random-walk model for studying energy penetration through paint films and a random-screen model for studying penetration of light through paint films are presented. The implication of Monte Carlo applications to random tracks across a circle is discussed for filtration studies, as Monte Carlo studies are applied to metal-filled conducting paint films. M.W.R.

N67-19214# United Kingdom Atomic Energy Authority, Culham (England). Research Group.
OPTICAL TRANSMISSION DATA FOR THIN ALUMINUM FILMS
W. M. Burton Aug. 1966 9 p refs
(CLM-R-64) HMSO: 1s 2d

The variation of the linear absorption coefficient of aluminum with wavelength between 1 Å and 6500 Å has been summarised using published data. Calculated transmission curves for typical aluminum filters are obtained with allowance for the additional absorption in an oxide layer. A filter of thickness 100° Å gives a useful transmission waveband at wavelengths below 80 Å and also between 170 Å and 700 Å, but is almost opaque (density ~6) at visible wavelengths. A simple method is described for estimating the thickness of aluminum filters by measurements of the optical transmission in white light. Author

N67-19251# Warsaw Univ. (Poland). Dept. of Radiochemistry.
GEODESIC MOTION IN GRAVITATIONAL FIELDS. 1: INTERNAL SCHWARZSCHILD FIELD
Bronislaw Kuchowicz Apr. 1966 36 p refs
CFSTI: $3.00

The motion of a test body with given mass, energy and angular momentum in an incompressible fluid sphere is studied in the framework of general relativity. Conditions for the physical parameters of the test body are derived under which the trajectory is of a closed type. It is found that for some choice of the physical parameters there exist two regions wherein particle motion is possible. These two regions form two completely separated domains. The results may be applied either to motion of elementary particles in superdense stars or to motion of celestial bodies in galaxies. Author

N67-19271*# Arkansas Univ., Little Rock. Dept. of Electronics and Instrumentation.
MEASUREMENT OF RAY DEVIATIONS IN AN OPTICALLY INHOMOGENEOUS FIELD
Robert L. Bond, George S. Ballard, and Joseph B. Story [1966] 7 p refs Submitted for Publication
(Grant NsG-713)
(NASA-CR-82463) CFSTI: HC $3.00/MF $0.65 CSCL 20F

Described is an experimental apparatus for recording the hologram of an optically inhomogeneous field by using a pulsed laser for image reconstruction. The image of the field is formed on a photographic plate which is also illuminated with a reference beam; both the angle and the direction of the ray deviation passing through the corresponding section of the field can thus be determined. Preliminary study results give an error of about 5%. G.G.

24 PHYSICS, ATOMIC, MOLECULAR, AND NUCLEAR

Includes atomic, molecular, and nuclear physics. For applications see: 22 Nuclear Engineering. For related information see also: 29 Space Radiation.

N67-18240* New York Univ., N. Y.
[STUDY OF HIGH ENERGY NUCLEAR REACTIONS AND SPACE RADIATION SHIELDING] Final Technical Report, 1 Mar. 1965–31 Aug. 1966
B. S. P. Shen 20 Sep. 1966 23 p refs
(Grant NGR-33-016-066)
(NASA-CR-81796) CFSTI: $3.00 CSCL 20H

Spatial distribution measurements of the activation products fluorine-18 and sodium-24 were made on aluminum foil in a plexiglass target. The target was bombarded in two separate irradiations by a beam of 2.2 and 2.9 GeV protons. Results showed that measured activities increased with depth and attained a broad plateau near the downstream end of the target. Also determined were energy distributions of fast neutrons emitted from a thin target of carbon bombarded by 1 GeV protons. G.G.

N67-18245 Atomic Energy of Canada, Ltd., Chalk River (Ontario).
PHYSICS DIVISION Progress Report, 1 Apr.–30 Jun. 1966
30 Jun. 1966 80 p refs
(AECL-2611; PR-P-70) CFSTI: $3.00

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4. NEUTRON PHYSICS BRANCH G. A. Bartholomew p 39–52 refs (See N67-18249 08-24)
5. THEORETICAL PHYSICS BRANCH H. H. Clayton p 53–71 refs (See N67-18250 08-24)

N67-18246 Atomic Energy of Canada, Ltd., Chalk River (Ontario).
SUMMARY
L. G. Elliott *In its* Phys. Div. 30 Jun. 1966 p 2–4 (See N67-18245 08-24) CFSTI: $3.00

Accomplishments in the fields of nuclear and solid state physics, solid state radiation detectors, and computation are summarized. The development of a gas target for use with the Tandem Accelerator is reported, and it is noted that the high resolution of lithium drifted germanium detectors permits Doppler shift attenuation lifetime measurements even in inelastic scattering proton reactions where the nuclear recoil is very small. The frequency wave vector dispersion relation for the normal vibration modes of tin telluride have been measured, and fabrication of coaxial diodes is continuing. It was found that CoF_2 has a body-centered tetragonal crystal structure and becomes antiferromagnetic and piezomagnetic below 37.7°K, and that crystal spectrometers for neutron scattering experiments utilize single crystals of weakly absorbing materials in order to

produce monoenergetic beams of neutrons and to analyze the energy distribution of neutrons scattered from a sample. The operation of the time-shared CDC-3100 satellite system and programs that have been written for use on the G-20 computer are also briefly mentioned. A.G.O.

N67-18247 Atomic Energy of Canada, Ltd., Chalk River (Ontario).
NUCLEAR PHYSICS BRANCH
G. C. Hanna *In its* Phys. Div. 30 Jun. 1966 p 5–19 refs (See N67-18245 08-24) CFSTI: $3.00

The progress of various research projects in the field of nuclear physics is discussed. Topics of study reported include: elastic and inelastic scattering of 14 MeV neutrons, U^{235} (d,pf) and Pu^{239} (d, pf) reactions, spectrum and angular distributions of ING target neutrons, gamma ray angular correlation measurements on levels in Si^{29}, Ne^{20} level analysis by radiative capture, lifetime of Mg^{24} levels, and gamma ray branching ratios of low-lying Si^{29} levels. A.G.O.

N67-18248 Atomic Energy of Canada, Ltd., Chalk River (Ontario).
GENERAL PHYSICS BRANCH
H. Carmichael *In its* Phys. Div. 30 Jun. 1966 p 20–38 refs (See N67-18245 08-24) CFSTI: $3.00

Research conducted in the fields of space physics, beta-ray spectroscopy, radioisotope standardization, and counter development is described. Progress is reported from studies on a digital temperature recording device, rapid scan operation of the $\pi\sqrt{2}\beta$ spectrometer, 57 and 350 keV states in Pr^{143}, deuterium cross sections, 3H standard measurements, 197Hg, standard gas counters, coaxial lithium drift germanium spectrometers, resolution deterioration due to charge trapping in Ge(Li) detectors, germanium quality, low noise preamplifiers, and encapsulated germanium spectrometers. A.G.O.

N67-18249 Atomic Energy of Canada, Ltd., Chalk River (Ontario).
NEUTRON PHYSICS BRANCH
G. A. Bartholomew *In its* Phys. Div. 30 Jun. 1966 p 39–52 refs (See N67-18245 08-24) CFSTI: $3.00

Work accomplished on several projects in the field of neutron physics is reported. Specific studies summarized include: anharmonic effects in potassium, lattice dynamics of transition-metal alloys, crystal dynamics of tin telluride, excitation in Co F_2, crystal dynamics and the ferroelectric phase transition in sodium nitrite, and high reflectivity germanium single crystals. Also discussed are studies on single crystal growth of krypton, sound velocity in solids, neutron diffraction from $Mn_{56}Zn_{44}$ and $Mn_{56}Zn_{34}Ge_{10}$, powder diffraction, 50Cr $(n,\gamma)^{51}$Cr gamma ray energies, the $(d,p\gamma)$ reaction in heavy elements, gamma ray resonant scattering from lead using Ge–Li detectors, positron annihilation gamma ray line, and gamma ray resonance scattering measurements using NaI detectors. A.G.O.

N67-18250 Atomic Energy of Canada, Ltd., Chalk River (Ontario).
THEORETICAL PHYSICS BRANCH
H. H. Clayton *In its* Phys. Div. 30 Jun. 1966 p 53–71 refs (See N67-18245 08-24) CFSTI: $3.00

The progress of research projects related to the field of theoretical physics is summarized. Data are presented from studies on the effects of space and image charges in a bunched beam, beam excitation, neutron fluxes in an ING facility, leakage flux in SOC magnets, SOC parameters by cost minimization, and linac shunt impedance. Consideration is also given to investigations concerning liquid theory and slow neutron scattering, projection techniques, structure of Si^{28}, phonon frequencies in transition metals, and computation. A.G.O.

N67-18297# General Dynamics Corp., San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science.
INTERACTIONS BETWEEN HYDROGEN AND OXYGEN ATOMS AND SURFACES Annual Technical Summary Report, Oct. 1, 1965–Sep. 30, 1966
Joe N. Smith, Jr. 27 Oct. 1966 26 p refs
(Contract AF 49(638)-1435)
(GA-7467; AFOSR-66-2740; AD-643013) CFSTI: HC $3.00/MF $0.65

The ultimate goal of the research program is to provide data concerning the transfer of energy and momentum between atoms and molecules and a solid surface in free-molecule flow, and to investigate other processes that may occur in the gas-surface interaction. The work during the reporting period was largely confined to two areas: light gas (He, H2, and D2) scattering from (111) Ag, and construction and testing of a compact slotted-disc velocity selector. In addition, some measurements were made of Ar scattering out of the plane of incidence. TAB

N67-18338*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
EVALUATION OF COULOMB INTEGRALS OF CONTINUUM FUNCTIONS
M. M. Saffren *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 165–167 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

The equation used in evaluating the essential matrix element of the interelectronic Coulomb energy is formulated, and the box normalization method of treating the integrals involving continuum wave functions is reviewed. It is shown that this integral is convergent, even in terms of the continuum wave functions themselves. Formulas for evaluating such integrals numerically are derived. M.G.J.

N67-18354*# National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York.
SOME EFFECTS OF NUCLEAR FORCES ON NEUTRON STAR MODELS
Sachiko Tsuruta and A. G. W. Cameron [1965] 70 p refs Submitted for Publication
(NASA-TM-X-57347) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Two composite equations of state were used in investigating the structure of neutron (or hyperon or baryon) stars; these are based upon two forms of the neutron–neutron potential. In one form repulsive forces come in quickly at greater than nuclear densities; in the other form the repulsive forces come in slowly. In the former case the maximum stable mass of a neutron star is about two solar masses; whereas in the latter case it is only about one solar mass. This probability represents a measure of the basic uncertainty in the properties of neutron star models due to lack of knowledge of nuclear forces. The maximum central density of a stable configuration is similarly uncertain; this density probably lies in the range 10^{15} to 10^{16} grams/cm^3. Details of many of the neutrons star models calculated are summarized and discussed. Author

N67-18372# International Center for Theoretical Physics, Trieste (Italy).
ABSOLUTE ft VALUES FOR FIRST FORBIDDEN β TRANSITIONS TO THE COLLECTIVE, NON-ROTATIONAL STATES OF THE TYPE $J^{\pi}K = 2^{+}2$
V. G. Soloviev (Joint Inst. for Nucl. Res.), D. Bogdan, S. Salagseanu, and N. Deciu (Inst. for Atomic Phys., Bucharest) Dec. 1966 9 p refs Submitted for publication
(IC-66-116) CFSTI: HC $3.00/MF $0.65

The absolute ft values for some first-forbidden β transitions to the collective γ-vibrational states have been calculated. Using the Kotani–Ross formalism the agreement between experimental and theoretical ft values is found to be nearly the same as for the transitions to the one- or two-quasiparticle states. Author (ESRO)

N67-18373# International Center for Theoretical Physics, Trieste (Italy).
FIRST FORBIDDEN β TRANSITIONS BETWEEN K-MIXED STATES
D. Bogdan and P. Lipnik Dec. 1966 24 p refs Submitted for publication
(IC-66-118) CFSTI: HC $3.00/MF $0.65

Assuming a K-mixture in the ground state of the ^{152}Eu nucleus it is possible to determine the relative intensity of the different K-components by comparison with the experimental data. The results are also valid for the ^{154}Eu and ^{160}Tb cases supposing the same Nilsson model configurations for these nuclei. In the case of the ^{170}Tm (1 − 1) ^{170}Yb (0+0; 2+0) beta transitions, the nuclear matrix elements were calculated admitting a K=0 mixture in the ^{170}Tm ground state. The results showed that, supposing reasonable K=0 mixtures, it is not possible to obtain satisfactorily calculated ft values. Author (ESRO)

N67-18428# Institut d'Aeronomie Spatiale de Belgique, Brussels.
COLLISION FREQUENCIES AND ENERGY TRANSFER: IONS
P. Banks 1966 41 p refs Submitted for publication /its Aeronomica Acta No. A 46
(Grant ONR-00009-66)
CFSTI: HC $3.00/MF $0.65

An investigation has been made of ion collision frequencies and energy transfer conditions of gaseous thermal nonequilibrium. Following the methods of electron collisions, the problem of ion-neutral and ion-ion elastic collisions have been considered under the assumption of separate Maxwellian velocity distributions. Expressions for the nonequilibrium momentum transfer cross sections, collision frequencies, and energy transfer rates are given for neutral gases. Next, the problem of ion-neutral resonance charge exchange is introduced in its effect upon collision cross sections and ion energy transfer rates. An analysis is made of gathered laboratory data to arrive at suitable expressions for the resonance charge exchange and momentum transfer cross sections for H^+, O^+, He^+, N_2^+, and O_2^+. Using these results, resonance charge exchange and momentum transfer collisions frequencies are derived. The resonance ion-neutral energy transfer rates are then presented and compared with expressions used in previous studies of ion temperatures. Author (ESRO)

N67-18429# Institut d'Aeronomie Spatiale de Belgique, Brussels.
COLLISION FREQUENCIES AND ENERGY TRANSFER: ELECTRONS
P. Banks 1966 41 p refs Submitted for publication /its Aeronomica Acta No. 47 A
(Grant ONR-00006-66)
CFSTI: HC $3.00/MF $0.65

A study is made of the problem of elastic collisions and energy transfer between gases which have separate Maxwellian velocity distributions. It is shown that the expression for the energy transfer rate obtained by Desloge for gases of arbitrary temperature and particle mass can be adapted into a convenient form which involves a ratio of particle masses, the difference in the gas thermal energies, and a collision frequency for energy transfer. An analysis is then made of the collision frequency in terms of an average momentum transfer cross section which is defined for conditions of thermal non-equilibrium. The general equations are next specialized to consider the problem of elastic electron collisions in heavy particle gases. To obtain useful numerical expressions for electron–neutral particle collision frequencies and energy transfer rates, an analysis has been made of the momentum transfer cross sections for N_2, O_2, O, H and He. Calculations have also been made of the Coulomb momentum transfer cross section, collision frequency, and energy transfer rate. Author (ESRO)

N67-18466# Brookhaven National Lab., Upton, N. Y. Accelerator Dept.
THE EFFECT OF QUADRUPOLE FRINGING FIELDS ON COUPLING IN LINACS
R. L. Gluckstern (Mass. Univ.) 7 Sep. 1966 8 p refs Presented at the Linear Accelerator Conf., Los Alamos, N. Mex., 3–7 Oct. 1966
(Contract AT(30-2)-GEN-16; Grant NSF GP-4476)
(BNL-10666; CONF-661021-6) CFSTI: HC $3.00/MF $0.65

The distortion of the transverse phase spaces due to fringing fields in the magnets of the strong focusing system was obtained. For a beam with fixed circular symmetry there is essentially no change in the radial oscillation amplitude. For a beam with rectangular cross section, there will be an increase in each transverse oscillation amplitude by of the order of 20% for typical linac designs. NSA

N67-18470# Gosudarstvennyi Komitet Po Ispolzovaniyu Atomnoi Energii, Moscow (USSR). Institut Teoreticheskoi i Eksperimental'noi Fiziki.
ELECTROMAGNETIC FORM-FACTORS OF TRANSITION AND INELASTIC SCATTERING OF ELECTRONS BY HADRONS [ELEKTROMAGNITNYE FORMFAKTORY PEREKHODA I NEUPRUGOE RASSEYANIE ELEKTRONOV NA ADRONAKH]
L. A. Kondratyuk 1966 16 p refs In RUSSIAN; ENGLISH summary
(Rept.-419; NP-16279)

The cross section and the density matrix for the inelastic scattering of the electron by a hadron with arbitrary spin in the one photon exchange approximation are determined in terms of electromagnetic form factors. The T-noninvariant effects and the angular distribution of the final hadrons in the process $e+N \to e'+N^*\to e'+N+\pi$ are discussed. Author (NSA)

N67-18471# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
ELASTIC E–D SCATTERING AND CP-INVARIANCE VIOLATION, II [UPRUGOE E–D RASSEYANIE I NARUSHENIE CP-INVARIANTNOSTI, II]
V. M. Dubovik, E. P. Likhtman, and A. A. Cheshkov 1966 10 p refs In RUSSIAN Submitted for publication
(JINR-P-2891)

Possibilities are discussed in detail of checking the CP violation in electromagnetic interactions of hadrons by using the correlation effects in elastic e–d scattering. It is shown in the one-photon approximation that, when the CP invariance is violated in scattering of electrons by a target polarized normally to the scattering plane, the angular asymmetry of recoil deuterons may be of about 10% at $q^2=12F^{-2}$ and $\vartheta_d=20°$. The contribution of the CP-invariant asymmetry is neglected. Author (NSA)

N67-18473# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems.
ASTATINE [ASTAT (OBZOR)]
V. D. Nefedov, Yu. V. Norseev, M. A. Toropova, and V. A. Khalkin 1966 35 p refs In RUSSIAN Submitted for publication
(JINR-P-2895)

A review is presented on the preparation and properties of astatine. Data on new inorganic and organic astatine forms are included. NSA

N67-18474# Brown Univ., Providence, R. I. Dept. of Physics.
ANALYSIS OF THE ELASTIC SCATTERING OF PROTONS AT HIGH ENERGY AND MOMENTUM TRANSFER USING THE SERBER MODEL AND BAKAMJIAN–THOMAS THEORY

David Avison (Ph.D. Thesis) Jun. 1966 89 p refs
(Contract AT(30-1)-2262)
(NYO-2262TA-129) CFSTI: HC $3.00/MF $0.65

The Serber model for describing proton–proton scattering was investigated in detail at two laboratory momenta, 11.26, and 30.0 BeV/c, by carrying out a partial-wave computation with the potential $A=(A_0A) = (\text{line}^{-\Delta r}/r,0,0,0)$ inserted into the Klein–Gordon equation $[(p_{op}-A)^2+m^2]\Psi = (E-A_0)^2\Psi$. The two resulting momentum transfer distributions obtained differ from those obtained by Serber, who used an optical approximation. Both curves are raised above Serber's in the high momentum transfer region. This causes the 11.26 BeV/c curve to be in better agreement with the data and the 30.0 BeV/c curve to over-shoot the data yielding worse agreement. The raising of these momentum transfer curves in the high momentum transfer region is due to the appearance of a real part in the low angular momentum contributions to the scattering amplitude. The Bakamjiam–Thomas theory was used to obtain relativistic scattering equations for the relative motion. These are presented in a squared and in an unsquared form and both forms are realized in Cartesian coordinates and reduced to partial wave equations for the case of an isotropic potential dependent only on the B.–T. relative coordinate. These equations are shown to bear a resemblance to the Klein–Grodon equation with Serber's potential A. The first Born approximation of the scattering amplitude as calculated from the Bakamjian–Thomas equations and from the Klein–Gordon equation are shown to agree as $k\to\infty$. Differences between these approaches are expected to show up mainly at large-angle scattering since the (unsquared) Bakamjian–Thomas Green's function differs appreciably from that of the Klein–Gordon equation only for small r. Author

N67-18479# Brookhaven National Lab., Upton, N. Y.
HIGH-ENERGY PHYSICS WITH THE BROOKHAVEN 80" HYDROGEN BUBBLE CHAMBER
J. A. Bamberger, D. P. Brown, W. B. Fowler, R. P. Shutt, C. L. Goodzeit et al 22 Jul. 1966 48 p refs
(Contract AT(30-2)-GEN-16)
(BNL-9065) CFSTI: HC $3.00/MF $0.65

A summary is presented on the development and operation of the BNL 80 in. bubble chamber for use in high energy physics. NSA

N67-18500*# Harvard Coll. Observatory, Cambridge, Mass. Shock Tube Spectroscopy Lab.
ANALYSIS OF ABSORPTION PROFILES OF AUTOIONIZING LINES
Bruce W. Shore Jan. 1967 31 p refs
(Grant NsG-438; Contract NASw-184)
(NASA-CR-82009; SR-15) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Scattering theory parameterization of absorption cross sections and refractivity for autoionizing spectral lines are discussed; and equations show the obvious connection between the absorption profile and the refractivity as a dispersion relation that can be expressed as an equivalent parameterization. The empirical determination of profile parameters and their physical significance is detailed; and it is noted that because of errors introduced in estimating the background level and resonance width, slight parameter adjustments are usually required to secure an optimum fit. Matrix elements of the atomic dipole moment or of an inter-electron coulomb potential express the interactions that contribute to the profile parameters of the autoionizing lines. Plotting of these profiles is described. M.W.R.

N67-18502# Battelle-Northwest, Richland, Wash. Theoretical Physics Unit.
MACHINE-ANALYSIS ABSTRACT—MAXIMUM LIKELIHOOD NONLINEAR VECTOR FIELDS—BATTELLE-NORTHWEST PROGRAM LIKELY
B. H. Duane *In its* Phys. Res. 15 Apr. 1966 p 1–2 (See N67-18501 08-22) CFSTI: HC $3.00/MF $0.65

The analysis logic used in the Likely computer program is reviewed. The maximum likelihood theory is constructed by solving the minimal misfit conditions; the nonlinear partial differential equations are solved by iterating second order analytic continuation to solid convergence. In the program, the maximum likelihood multidimensional vector fields are constructed to satisfy any statistical or deterministic linear or nonlinear vector field theory, cast as a variational extremal subject to correlated statistic or implicit anholonomic constraints. M.G.J.

N67-18521# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
ON POSSIBILITY OF QUARK-MOLECULE FORMATION [O VOZMOZHNOSTI OBRAZOVANIYA KUARKOMOLEKUL]
V. B. Belyaev 1966 13 p refs In RUSSIAN
(JINR-P-2871)

A possibility is considered of the formation of molecules (similar to that of hydrogen) with quarks instead of protons. The spectrum of these systems differs from that of hydrogen molecule. Author (NSA)

N67-18526# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
ON THE THEORY OF UNITARY REPRESENTATIONS OF THE SL(2,c) GROUP [K TEORII UNITARNYKH PREDSTAVLENII GRUPPY SL(2,c)]
Dao Wong Duc and Nguyen Van Hieu 1966 22 p refs In RUSSIAN
(JINR-P-2888)

On the basis of the homogeneous functions the bases of the unitary representations of the SL(2,c) group are evidently constructed. The matrix elements of the finite transformations are calculated. The most degenerate principal series of representations of the SL(n,c) group is also considered. Author (NSA)

N67-18527# Deutsche Akademie der Wissenschaften zu Rossendorf (East Germany). Zentralinstitut fuer Kernforschung.
ON THE INFLUENCE OF PAIRING CORRELATIONS ON E1 TRANSITIONS IN ODD DEFORMED NUCLEI IN THE REGION OF THE RARE EARTHS [UEBER DEN EINFLUSS VON PAARKORRELATIONEN AUF E1-UEBERGAENGE IN UNGERADEN DEFORMIERTEN KERNEN IM GEBIET DER SELTENEN ERDEN]
Wolfgang Meiling and Franz Stary Feb. 1966 28 p refs In GERMAN; ENGLISH summary
(ZFK-PHA-21)

A survey was made of the calculation of single-particle transition probabilities according to the Nilsson model, and theoretical transition probabilities were compared with experimental values of E1 transitions in deformed odd-A nuclei of the rare-earth region. It can be shown that the agreement between theoretical E1 transition probabilities using the Nilsson model and experimental data is not improved by considering pairing correlations. Because of the great inaccuracy of the calculated pairing correction factor fry, no systematic differences in the theoretical transition probabilities compared to the experimental values can be recognized. Author (NSA)

N67-18528# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
OPTIMUM SEPARABILITY CONDITION FOR THE ROTATIONAL DEGREE OF FREEDOM AND THE NUCLEAR MOMENT OF INERTIA [USLOVIE OPTIMAL'NOGO VYDELENIYA ROTATSIONNOI PEREMENNOI I MOMENT INERTSII YADRA]

I. N. Mikhailov, E. Nadzhakov, and R. Kh Safarov 1966 16 p refs In RUSSIAN
(JINR-P-2866)

The optimum separability condition for the rotational degree of freedom is used to determine the rotational spectra parameters of nuclei. An empirical formula which provides a very good numerical fit for the energies of states with $0 \leq I \leq 16$ is discussed. Author (NSA)

N67-18530# California Univ., Livermore. Lawrence Radiation Lab.
ON THE POSSIBILITY OF RADIAL LOSSES OF THE E-LAYER DURING THE INJECTION PHASE DUE TO THE NEGATIVE MASS INSTABILITY
N. C. Christofilos 31 Aug. 1966 5 p
(Contract W-7405-ENG-48)
(UCID-15018) CFSTI: HC $3.00/MF $0.65

Some preliminary results on measuring radial losses of the E-layer during the first pass along the machine lead to the premature conclusion that the negative mass instability may cause unlimited losses of the injected electrons, namely causing a continuous exponential decay of the injected current along the Astron tank. In order to dispel the thus created confusion, the possibility of radial losses is discussed by describing and calculating the effect of the negative mass instability. NSA

N67-18531# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
DISPERSION SUM RULES FOR ANNIHILATION PROCESS [DISPERSIONNYE PRAVILA SUMM DLYA PROTSESSA ANNIGILYATSII]
V. A. Matveev 1966 7 p refs In RUSSIAN
(JINR-P-2879)

The dispersion sum rules are considered for the annihilation process of baryon–antibaryon octets into a pair of meson octets in the framework of the unitary symmetry. Some relations, which connect meson–meson and meson–baryon coupling constants, are obtained. They are in good agreement with experiment. Author (NSA)

N67-18532# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
DISPERSION SUM RULES AND THE CABIBBO–RADICATI RELATION
R. N. Faustov, R. E. Kallosh, and V. G. Pisarenko 1966 8 p refs Submitted for publication
(JINR-E-2865)

It is shown that the sum rules for electroproduction and the Cabibbo–Radicati relation can be obtained from a certain assumption about the high-energy behavior of the virtual isovector amplitude of the Compton scattering on the proton without recourse of current algebras. Author (NSA)

N67-18537# Maryland Univ., College Park. Dept. of Physics and Astronomy.
EVIDENCE FOR A DOUBLET AT 5.96 MeV IN ^{10}Be
F. C. Young, P. D. Forsyth, M. L. Roush, and W. F. Hornyak Jan. 1966 15 p refs Presented at the Conf. on Bases for Nucl. Spin-Parity Assignments, Gatlinburg, Tenn., 11–13 Nov. 1965
(Contract AT(40-1)-2098)
(ORO-2098-49; CONF-651118-18; TR-538) CFSTI: HC $3.00/MF $0.65

By using the ^{9}Be(d,pγ)^{10}Be reaction to populate the 5.96-MeV state in ^{10}Be, gamma coincidence spectra were measured across the proton group corresponding to this state. The protons were detected with a solid-state detector at the exit of a magnetic spectrometer, which was used to scan the proton group. The yields of the cascade gamma rays (2.59 and 3.37 MeV) and the crossover gamma ray (5.96 MeV) were extracted from coincidence spectra measured with a 3 in.×3 in. NaI crystal. The ratio of the cascade yield to the crossover yield is observed to change by a factor of 2 across the proton group. This variation of the branching ratio across the level is interpreted as evidence for the existence of two closely spaced levels at 5.96-MeV excitation. These two levels are separated by about 1 KeV. The higher-energy member of this doublet decays predominately by the crossover transition and has $J^{\pi}=1^{-}$. The lower-energy member decays predominately by the cascade transition and has $J^{\pi}=2^{+}$. Author (NSA)

N67-18538# Carnegie Inst. of Tech., Pittsburgh, Pa.
EXPERIMENTAL TEST OF THE $\Delta Q=\Delta S$ RULE IN NEUTRAL LEPTONIC K-DECAY
Y. Cho, J. Canter, A. Dralle, A. Engler, H. E. Fisk et al 1966 17 p refs Presented at the 13th Intern. Conf. on High Energy Phys., Berkeley, Calif. Prepared jointly with Brookhaven Natl. Lab.
(Contract AT(30-2)-GEN-16)
(BNL-10609; CONF-660808-16) CFSTI: HC $3.00/MF $0.65

Data are presented for an exposure of the 30 in. BNL chamber, filled with deuterium, to a 600 MeV/c K^{+} beam at the AGS. Approximately 2.5×10^{5} pictures, with an average flux of 13 K^{+} per picture and an equal number of background tracks, were taken. An additional 10^{5} pictures with a flux of 25 K^{+} per picture and less than 10% background tracks were also taken. Neutral K's were obtained from the reaction $K^{+}+d \rightarrow K^{0}+p+p$. The pictures were scanned for V's independent of production origin. NSA

N67-18539# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
DISPERSION RELATIONS AND ELEMENTARY LENGTH IN QUANTUM FIELD THEORY [DISPERSIONNYE SOOTNOSHENIYA I FUNDAMENTAL' NAYA DLINA V KVANTOVOI TEORII POLYA]
A. A. Logunov and Nguyen Van Hieu 1966 11 p refs In RUSSIAN
(JINR-P-2873)

A possibility is considered of studying the asymptotic behavior of the scattering amplitudes in the complex energy plane. It is shown that if the scattering amplitudes increase exponentially in the complex plane, an accurate experimental determination of the cross sections in the physical region allows one to estimate the amplitude growth in the complex plane and may yield thereby some information concerning the elementary length in quantum field theory. Author (NSA)

N67-18581# Syracuse Univ., N. Y. Dept. of Physics.
DYNAMICAL GROUP OF A SIMPLE PARTICLE MODEL
A. Boehm Aug. 1966 15 p refs
(Contract AT(30-1)-3399)
(NYO-3399-77; Rept.-1206-SU-77) CFSTI: HC $3.00/MF $0.65

The description of physical systems by dynamical groups is very likely to be equivalent to the usual quantum mechanical description. Assuming this equivalence the physical system of a strongly interacting particle is examined by the enveloping algebra of a dynamical group which is connected with the question as to whether or not the usual quantum mechanical laws alone govern this physical system. NSA

N67-18582# Oak Ridge National Lab., Tenn.
DIFFERENTIAL SCATTERING OF NEUTRONS FROM OXYGEN AND INTERMEDIATE STATES
J. L. Fowler and C. H. Johnson [1966] 9 p refs Presented at the Intern. Conf. on Nucl. Phys., Gatlinburg, Tenn., 12–17 Sep. 1966
(Contract W-7405-ENG-26)
(ORNL-P-2434; CONF-660906-19) CFSTI: HC $3.00/MF $0.65

The explanation of the broad structure in the total neutron cross section of ^{16}O between 3 and 4 MeV is of importance to the understanding of intermediate states. At 3.77 under a 17-KeV $f_{7/2}$ resonance a 3-KeV $d_{3/2}$ resonance interfering with a large $d_{3/2}$ phase shift is found; thus a difficulty in resonance parameter assignments at the peak is removed. Author (NSA)

N67-18585# Brookhaven National Lab., Upton, N. Y.
THE INFLUENCE OF RADIATION ON METALLURGICAL PROCESSES
G. J. Dienes [1966] 58 p refs Presented at the Cairo Solid State Conf., 3–6 Sep. 1966
(Contract AT(30-2)-GEN-16)
(BNL-10543; CONF-660923-1) CFSTI: HC $3.00/MF $0.65

The processes that take place when various radiations impinge on solids are summarized. Particular attention is given to enhanced diffusion and defect trapping in metals and nonmetals. The theory is reviewed, and some representative experiments are discussed. Metallurgical reactions resulting from enhanced diffusion coefficients are pointed out. NSA

N67-18590# International Centre for Theoretical Physics, Trieste (Italy).
INFINITE-DIMENSIONAL IRREDUCIBLE REPRESENTATIONS OF LIE ALGEBRAS OF COMPACT UNITARY GROUPS
J. Fischer and R. Raczka Sep. 1966 41 p refs Submitted for Publication
(IC-66-101)

The discrete and continuous series of infinite-dimensional irreducible representations of Lie algebras of compact unitary groups are derived and their properties are discussed. The possible physical applications are pointed out. Author (NSA)

N67-18592# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy.
INVESTIGATION OF THE $\pi^- p \to \pi^+ + \pi^- + m\pi^0 + n$ AND $\pi^- p \to 2\pi^+ + 2\pi^- + m\pi^0 + n$ [ISSLEDOVANIE REAKISII $\pi^- p \to \pi^+ + \pi^- + m\pi^0 + n$ i $\pi^- p \to 2\pi^+ + 2\pi^- + m\pi^0 + n$]
Ya. Bem, V. G. Grishin, E. P. Kistenev, D. K. Kopylova, A. G. Krivent-sova et al 16 Aug. 1966 34 p refs In RUSSIAN Submitted for Publication
(JINR-P-2885)

The $\pi^- + p \to n + \pi^+ + \pi^- + m\pi^0$ and $\pi^- + p \to n + 2\pi^+ + 2\pi^- + m\pi^0$ interactions at momentum 4 GeV/c were investigated. $\pi^- p$ interactions, involving γ quanta, which produced e^+e^- pairs in the effective volume of a propane chamber were recorded. The events, first one with the production of one and two π^0 mesons ($\sigma(1\pi^0) = 3.8 \pm 0.7$ mb; $\sigma(2\pi^0) = 3.6 \pm 0.3$ mb) were singled out. The first reaction with m = 2 was investigated in detail. It was shown that in the first reaction the production cross sections of ω,ρ, and η mesons are small ($\sigma \leq 0.2$ mb). Data are obtained indicating the intensive production of the nucleon isobars N*(1688) and N*(2190). It is also shown that, on the whole, a π^0 meson is produced in the second reaction. Author (NSA)

N67-18593# Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies.
$K^- p \to K^- p$ DIFFRACTION AND RESONANT SCATTERING IN THE GeV REGION
R. Levi Setti and E. Predazzi Aug. 1966 16 p refs Presented at the 13th Intern. Conf. on the High Energy Phys., Berkeley, Calif., Aug. 1966
(Contracts AT(11-1)-284; AF 49(638)-1652)
(COO-264-343; EFINS-66-80; CONF-660808-13) CFSTI: HC $3.00/MF $0.65

An analysis of $K^- p$ elastic scattering data from .8 to 20 BeV/c suggests that diffraction scattering contributes throughout. A model which includes resonant and diffractive effects gives a good fit to the experimental data in the 1 BeV/c region. Author (NSA)

N67-18594# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems.
INVESTIGATION OF THE MECHANISM OF π^--MESON RADIATIVE CAPTURE BY COMPLEX NUCLEI [ISSLEDOVANIE MEKHANIZMA RADIATSIONNOGO ZAKHVATA π^--MEZONOV SLOZHNYMI YADRAMI]
V. I. Petrukhin, V. S. Pogosov, and Yu. D. Prokoshkin 18 Aug. 1966 19 p refs In RUSSIAN Submitted for Publication
(JINR-P-2901)

It is proved by the experiment that neutron escape in the direction opposite to that of γ quantum takes place at the radiative capture of π^- mesons by the Li nuclei. All the peculiarities of the observed process agree with the assumption about one-nucleon mechanism of the radiative capture of π^--mesons by nuclei. Author (NSA)

N67-18597# Ludwig-Maximilians-Universitat, Munich (West Germany). Erstes Physikalisches Institut.
INVESTIGATIONS INTO ATTACHMENT PROPERTIES OF RADIOACTIVE AEROSOLS [UNTERSUCHUNGEN UEBER ANLAGERUNGSVORGAENGE RADIOAKTIVER AEROSOLE]
V. Mohnen May 1966 58 p refs In GERMAN; ENGLISH summary
(BMWF-FB-K-66-11)

The attachment of small ions and radioactive decay products (from Radon or Thoron) to aerosols was studied, starting with the exact solution of the diffusion equation. For the first time, all parameters in this equation are discussed, and all possibilities to simplify the resulting equation are theoretically examined for deviations from the exact value. Also a strong differentiation was made between the attachment of neutral and electrically loaded, radioactive decay products. The time for ion capture and neutral decay product capture to a given aerosol mixture was calculated. A method to determine the total number of particles and their size spectrum (using a cylindrical condensor as particle discriminator) was theoretically established. Author (NSA)

N67-18599# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
ON A METHOD OF SOLVING OF THREE-BODY PROBLEM BY USE OF STURM-LIOUVILLE FUNCTIONS [O METODE RESHENIYA ZADACHI TREKH TEL S ISPOL'ZOVANIEM FUNKTSII SHTURMA-LIUVILLYA]
B. N. Zakhar'ev 2 Jul. 1966 12 p refs In RUSSIAN
(JINR-P-2825)

The use of eigenfunctions of Sturm–Liouville as a basis for decomposition of a wave function of a many-body system instead of usual wave functions in the configuration mixing methods of Feschbach and Born–Oppenheimer permits the calculations to be more precise without additional complications. Author (NSA)

N67-18600# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
ON THE COMPLETENESS CONDITION IN POTENTIAL SCATTERING THEORY [OB USLOVII POLNOTY V TEORII POTENTSIAL'NOGO RASSEYANIYA]
A. A. Khelashvili 4 Aug. 1966 8 p refs In RUSSIAN
(JINR-P-2869)

It is shown that the orthogonality of wave functions leads to the unitarity of the physical scattering amplitude. The completeness condition together with the asymptotical behavior of the wave functions is equivalent to the non-relativistic dispersion relations. Author (NSA)

N67-18804# California Univ., La Jolla.
COMPARISONS BETWEEN ON-SHELL AND OFF-SHELL METHODS FOR THE TWO-BODY T-MATRIX
G. Marchesini (Milan Univ.) and D. Y. Wong Aug. 1966 11 p refs Presented at the 13th Intern. Conf. on High Energy, Berkeley, Calif. Submitted for publication
(Contract AT(11-1)-GEN-10)
(UCSD-10P10-9; CONF-660808-15) CFSTI: HC$3.00/MF$0.65

The nonrelativistic Low equation is extended to include the relativistic phase space factor and to allow a general velocity dependent potential. A method for solving the Low equation is derived and applied to NN, $N\bar{N}$, and $\pi\pi$ scattering problems. The results are compared to the solutions of the on-shell ND^{-1} equations. NSA

N67-18808# Syracuse Univ., N. Y. Dept. of Physics.
CURRENT ALGEBRAS, THEORY, AND APPLICATIONS
A. P. Balachandran, M. G. Gundzik, and F. Nicodemi Aug. 1966 24 p Presented at the Boulder Conf. on Particle Phys., 1966
(Contract AT(30-1)-3399)
(CONF-660638-1; NYO-3399-78) CFSTI: HC$3.00/MF$0.65

An approach to current algebras which differs from those developed by Fubini and co-workers in that in the latter, one always ends up with sum rules relating physical parameters. Local statements are obtained about off-mass-shell extrapolations of scattering amplitudes and a definite set of rules for computing scattering amplitudes of a physical mass boson (pion or kaon) is developed from a knowledge of the behavior of the extrapolated amplitude in the neighborhood of the point where the four-momentum of the boson vanishes. The technique of computation is described in detail for π^+p scattering. NSA

N67-18810# Brookhaven National Lab., Upton, N. Y.
ANALYSIS OF ISOBAR PRODUCTION IN p+p AT 28.5 BeV
P. L. Connolly et al 1966 12 p refs Presented at the 13th Intern. Conf. on High Energy Phys., 31 Aug.–7 Sep. 1966
(Contract AT(30-2)-GEN-16)
(CONF-660808-11; BNL-10573) CFSTI: HC$3.00/MF$0.65

Experimental results are presented of a study of isobar production in p–p interactions at 28.5 BeV. The charged decays of the isobars were observed and the quantum numbers of possible resonant states were determined. In particular, the 1400 enhancement which, according to the phase shift analysis, should be a P_{11} resonance was studied. NSA

N67-18813# Los Alamos Scientific Lab., N. Mex.
ANGULAR ANISOTROPY OF PHOTOFISSION AND PARITY OF GROUND STATE OF Pu-239
S. P. Kapitsa and Iu. M. Tsipeniuk [1966] 14 p refs Transl. into ENGLISH of the Rept. FEI-12 by Gos. Kom. Po Ispol'zovaniyu At. Energ. Inst.
(LA-TR-66-46) CFSTI: HC$3.00/MF$0.65

Angular distributions of fragments in the photofission of ^{239}Pu by quanta braking radiation from a microtron of the limiting energy interval E_{max}=5.4 to 7.9 MeV were measured. Anisotropic angular distributions of the $W(\vartheta)=a+b\sin^2\vartheta$ type were observed with E_{max}=5.4, 5.65, and 5.9 MeV. Maximum anisotropy complying with b/a=0.192 was recorded with E_{max}=5.65 MeV. A comparison of the results with the data on the fission of ^{238}Pu induced by neutrons allows a parity of the ground state of ^{239}Pu to be determined as against the parity of the ground states of an even-even nucleus. The data on fission are in accord with the positive parity of ^{239}Pu resulting from spectroscopic data. Author (NSA)

N67-18818# California Univ., Berkeley. Lawrence Radiation Lab.
DETERMINATION OF THE ENERGY DEPENDENCE OF THE FORM FACTOR IN $K+_{e3}$/DECAY
George E. Kalmus and Anne Kernan 20 Aug. 1966 12 p Presented at the 13th Intern. Conf. on High Energy Phys., Berkeley, Calif., 27 Aug.–7 Sep. 1966
(Contract W-7405-ENG-48)
(CONF-660808-12; UCRL-17087) CFSTI: HC$3.00/MF$0.65

The decay $K^+ \rightarrow \pi^0+e^++\nu$ where $\pi^0 \rightarrow 2\gamma \rightarrow 2e^+$ was studied using K^+ mesons in a heavy liquid bubble chamber. All the tracks from the decay were measured by means of the Behr–Mittner method for calculating the momenta and errors. NSA

N67-18819# International Center for Theoretical Physics, Trieste (Italy).
DECOMPOSITIONS OF DISCRETE MOST DEGENERATE REPRESENTATIONS OF $SO_0(p,q-1)$ OR $SO_0(p-1,q)$
J. Niederle Aug. 1966 23 p refs
(IC-66/99)

The decomposition of any most degenerate unitary irreducible representation (single-valued of discrete principal series) of an arbitrary noncompact rotation group $SO_0(p,q)$ ($p \geq q > 1$) with respect to the unitary irreducible representations of its maximal noncompact rotation subgroup $SO_0(p,q-1)$ or $SO_0(p-1,q)$ is derived and characteristic features of the decomposition are discussed. Author (NSA)

N67-18836*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
HOMOGENEOUS CANONICAL FORMALISM AND RELATIVISTIC WAVE EQUATIONS
Albert A. Jackson, IV (M.A. Thesis—N. Tex. State Univ.) Aug. 1966 68 p refs
(NASA-TM-X-58005) CFSTI: HC$3.00/MF$0.65 CSCL 20J

A classical canonical formalism was developed and the usual transition schema to quantum dynamics is presented. The question of transition from relativistic mechanics to relativistic quantum dynamics is answered by developing a homogeneous formalism which is relativistically invariant. Using this formalism the Klein–Gordon equation was derived as the relativistic analog of the Schroedinger equation. Using this formalism further, a method of generating other relativistic equations with spin is presented. Further studies, such as the Heisenberg formulation of quantum dynamics; the geometry of the linearized metric; and other possible kinds of metric that might be explored with the developed canonical formalism, are proposed. L.S.

N67-18843# United Kingdom Atomic Energy Authority, Culham (England).
ELECTRON IMPACT IONIZATION CROSS-SECTIONS OF IONS
I. L. Beigman and L. P. Presnyakov Apr. 1966 8 p refs Presented at the Culham Conf. on Ultraviolet and X-ray Spectry. of Lab. and Astrophys. Plasmas, Culham, England, Mar.–Apr. 1966
(CTO-282; CONF-660332-1) CFSTI: HC$3.00/MF$0.65

For an investigation of a high-temperature plasma it is essential to know the ionization and excitation cross sections of the ions by electron impact. When calculating such cross sections the long-range Coulomb field of the ion must be taken into account as its effect on the behavior of the cross section near threshold is important. To show the importance of the Coulomb field of the ion, the ionization cross sections were calculated for different states of the C^{5+} and C^{4+} ions, and the results were averaged over a Maxwellian velocity distribution. NSA

N67-18648# California Univ., Berkeley. Lawrence Radiation Lab.
PREDICTIONS OF NEW MAGIC REGIONS AND MASSES FOR SUPER HEAVY NUCLEI FROM CALCULATIONS WITH REALISTIC SHELL MODEL SINGLE PARTICLE HAMILTONIANS
Heiner Meldner 9 Aug. 1966 17 p refs Presented at Intern. Symp. on Why and How Should We Investigate Nuclides Far Off The Stability Line, Lysekil, Sweden, 21–27 Aug. 1966
(Contract W-7405-ENG-48)
(UCRL-16843; CONF-660817-6) CFSTI: HC $3.00/MF $0.65

The single-particle part of a realistic shell model Hamiltonian is considered to contain a nonlocal potential similar to the classic Van Vleck nuclear potential. It was possible to get a constant fit to (1) nuclear charge density distributions including isotope effects, (2) 1s proton levels as measured in (e,e'p) scattering, (3) total binding energies or nuclear mass defects, while (4) reproducing the shell model level sequences, i.e., spin assignments. Extrapolations to nuclei off the stability valley and to super heavy nuclei appear to be reasonable. In the latter case some evidence was found for a double magic nucleus at proton number 114 and neutron number 184 with a total binding energy around 2200 MeV. There is no indication of a double magic nucleus with Z=126, N=184 close to the line of β stability. However, some support was found for a relatively long-lived compound nucleus with these nucleon numbers by investigating metastable proton states. Author (NSA)

N67-18708*# Oak Ridge National Lab., Tenn.
NEUTRON PHYSICS DIVISION Annual Progress Report, Period Ending 31 May 1966
Sep. 1966 42 p refs
(NASA Order R-104; Contract W-7405-ENG-26)
(NASA-CR-77981; ORNL-3973, Vol. II) CFSTI: HC $3.00/MF $0.65 CSCL 18F

Theoretical and experimental studies for high energy radiation shielding are summarized, as are results of radiation detection investigations. Shielding studies deal with radiation hazards to space vehicles and supersonic jet aircraft, dosages and radiochemical cross sections, emission spectra from various particle collisions, and Monte Carlo calculations. Others review various level proton bombardments, neutron-production cross sections, and beam energy measurements. Lithium-drifted germanium detectors are considered, along with the connection of amplifier systems to semiconductor systems and a proton recoil spectrometer. M.W.R.

N67-18719 Polish Academy of Sciences, Cracow. Inst. of Nuclear Physics.
HIGH RESOLUTION TRANSVERSE SUM RULES FOR ELECTRONS SCATTERED INELASTICALLY FROM LIGHT NUCLEI
Wieslaw Czyz, Leonard Lesniak, and Andrzej Malecki Jun. 1966 50 p refs Submitted for publication
(Rept.-485/PL) CFSTI: $3.00

A series of sum rules for inelastic electron scattering at $0=180°$ is proposed. Each of them contains contributions from transitions of a given multipolarity. This approach is applied to study the form factors of the Giant Dipole Resonance and the results are compared with the existing experimental data and the results of calculations based on the microscopic theory of the dipole vibrations in nuclei. Author

N67-18776# California Univ., Berkeley. Lawrence Radiation Lab.
A 1.2–1.9 BeV/c, SEPARATED K^- MESON BEAM: DESIGN AND CONSTRUCTION
Janice Button-Shafer, George R. Kalbfleisch, Donald H. Miller, Janos Kirz, Charles G. Wohl et al 28 Jul. 1966 44 p refs
(Contract W-7405-ENG-48)
(UCRL-17018) CFSTI: HC $3.00/MF $0.65

Because of repeated inquiries concerning the design of the "K-72" separated beam, a rough description of some of the design considerations and tuning results is presented here. This report describes the design and operation of a variable-momentum, separated K^- meson beam for an experiment in the 72-inch hydrogen bubble chamber at the Bevatron. The beam momentum was variable over the region 1.25 to 1.95 BeV/c. With two stages of electromagnetic separation, the beam channel measured 155 ft (target to bubble chamber); it afforded a pion rejection factor of about 10^5. The K^- meson flux at the chamber was about 10 K^- per 10^{11} protons at the higher momenta, and somewhat less at the lower. Beam contamination (by pions and muons) was $\leq$ 10 percent. A total exposure of about 14,000 events per millibarn was made. Author

N67-18798# Brookhaven National Lab., Upton, N. Y.
CROSS SECTION DATA COMPILING—PRESENT AND FUTURE
Murrey D. Goldberg *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 226–234 Sponsored by AEC (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

The present status of services rendered by Sigma Center (the Neutron Cross Section Compilation Group at Brookhaven) is described. The cross section data library on magnetic tape is presented, along with some of its present problems and the proposals for solution. The growing difficulties of maintaining compact presentation of cross section data in publication form are demonstrated, and the future of such publications is discussed. Author

N67-18799# Oak Ridge National Lab., Tenn.
FILLING IN GAPS WITH CROSS SECTIONS CALCULATED FROM THEORY
F. G. Perey *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 235–246 refs (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

It is shown that theoretical models may be used very successfully to fill gaps in present sets of neutron cross section data for the elastic and inelastic scattering of neutrons in the energy range below 16 MeV. Some limitations of the theoretical models are pointed out and areas where improvements can be expected are discussed. It is suggested that elastic scattering data obtained from optical model calculations would be adequate for many applications of interest. For neutron inelastic scattering at low energies, there is a need for more adequate measurements as well as nuclear structure information on the spins and parities of excited states. At the higher energies, theory can provide the evaporation spectrum and the most important neutron inelastic groups, which may be sufficient for many practical applications. Author

N67-18800# Atomic Weapons Research Establishment, Aldermaston (England).
MECHANISED EVALUATION OF NEUTRON CROSS SECTIONS
K. Parker *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 247–250 refs Presented at the Conf. on Neutron Cross Sect. Technol., Washington, D. C. 22–24 Mar. 1966 (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

Accurate multigroup neutronics calculations cannot easily be carried out without internally consistent neutron cross section data for many materials over a wide energy range. Possible ways of increasing the output of neutron cross section evaluations are discussed. The most promising appears to be direct analysis of data from the Sigma Center Information and Retrieval System tape on a digital computer using sophisticated curve fitting techniques. This method is illustrated by scattering angular distributions and fast neutron capture and fission cross sections. Development of such methods could solve the problem of revision of existing

evaluations in the light of new experimental results. The implications of this approach for the presentation of experimental and theoretical neutron cross section data are discussed. Author

N67-18801# Brookhaven National Lab., Upton, N. Y.
DIFFERENTIAL AND INTEGRAL CROSS SECTIONS FOR THE TRANSURANIUM ELEMENTS
S. Pearlstein *In* AEC Neutron Cross Sect. Technol. Mar. 1966 p 251–258 Sponsored by AEC (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

Cross sections useful for determining the production of transuranium elements are evaluated using the Breit–Wigner single level formula. Thermal cross sections and resonance integrals for neutron capture and fission are presented for the U^{234}, U^{236}, Np^{237}, Pu^{238}, Pu^{240}, Pu^{241}, Pu^{242}, Am^{241}, Am^{243}, and Cm ^{244}nuclides. Author (NSA)

N67-18805# Atomic Weapons Research Establishment, Aldermaston (England).
COMPUTER EVALUATION OF NEUTRON SCATTERING ANGULAR DISTRIBUTION DATA
A. Horsley *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 293–303 refs Presented at the Conf. on Neutron Cross Sect. Technol., Washington, D. C., 22–24 Mar. 1966 (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

A Fortran program is described which produces evaluated angular distribution data for incident neutron energies up to 30 MeV for a given nuclide from the experimental differential cross section data which are available. A cubic spline routine is used to first "draw" a curve to the data points; the spline routine adjusts each data point within some assigned multiple of its standard deviation (or eliminates it as an inconsistent data point) so that a smooth curve is obtained in a manner analogous to the use of a draughtsman's spline. The data points and a suitable number of interpolates and extrapolates are fitted by least squares Legendre polynomial analysis and collectively evaluated by examining the energy variation of the Legendre coefficients. Author

N67-18808# IIT Research Inst., Chicago, Ill.
CROSS SECTION CALCULATIONS THROUGHOUT THE PERIODIC TABLE
D. A. Klopp *In* AEC Neutron Cross Sect. Technol. Mar. 1966 p 315–327 refs Sponsored by NASA (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

A simple self-consistent formalism for the estimation of (n,γ), (n,p), (n,α), and $(n,2n)$ cross sections has been developed for use in survey calculations of neutron activation. The only required information is the Z and A of the target nucleus. The (n,p), (n,α), and $(n,2n)$ cross sections are calculated using a statistical compound nucleus model with a Fermi gas level density. Generally good agreement has been obtained upon comparison with experimental data. Semi-empirical formulae have been constructed for the estimation of unknown thermal (n,γ) cross sections. Epithermal (n,γ) cross sections are estimated by a statistical resonance treatment; this method gives poor agreement with experimental data. Author

N67-18809# Oak Ridge National Lab., Tenn.
IMPOSSIBLE LEGENDRE COEFFICIENTS
D. C. Irving, R. R. Coveyou, and R. D. MacPherson *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 328–334 ref Sponsored by AEC (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

It has long been realized that Legendre Polynomial expansions of differential cross sections can result in negative cross-section values due to the truncation of the infinite series. It is also possible that a given set of Legendre coefficients may result in negative cross sections because they do not represent any physically possible, everywhere positive angular distribution. The mathematical criteria that must be satisfied in order that there exist an everywhere positive distribution having a given set of Legendre coefficients are discussed. A check of Legendre coefficients from several published sources has revealed a surprisingly large number of instances where the coefficients are impossible. A computer program is offered which will examine a set of Legendre coefficients to determine if they can be derived from a possible distribution. Author

N67-18810# Atomics International, Canoga Park, Calif.
COMPILATION, EVALUATION AND REDUCTION OF NEUTRON DIFFERENTIAL SCATTERING DATA
S. K. Davis *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 335–353 refs (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65
(Contract AT(11-1)-GEN-8)

The Atomics International Cross Section Analysis and Applications Project has recently completed a compilation of available data on angular distributions of elastically scattered neutrons, as well as the analysis and reduction of this data into forms convenient for computer calculations. This elastic differential scattering data is represented by expansions in a finite series of Legendre polynomials with energy-dependent coefficients in the center-of-mass system. The present investigation has pinpointed several areas in which the standard methods of presenting and analyzing experimental data are unsatisfactory. The effect on some neutronic calculations of using an insufficient number of Legendre coefficients to represent the angular data is illustrated. Author

N67-18812# Columbia Univ., New York.
CAPABILITIES AND LIMITATIONS OF TIME-OF-FLIGHT NEUTRON SPECTROSCOPY BETWEEN 100 eV and 100 keV
James Rainwater *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 381–403 refs (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

The various factors involved in the measurement of neutron cross sections are described. For total cross section measurements, the principal factor is to obtain a correct evaluation of the energy and sample dependent background corrections. Carefully conceived and executed separate experiments, interlaced with the main experiment, are required. The standard plots of σ vs E may be very misleading for the user for various reasons which are discussed. For experiments which measure scattering or capture directly, the above considerations also apply. In addition, one must also be concerned with an accurate evaluation of the detector efficiency and the neutron flux vs energy. Self shielding or multiple interactions in the scattering or capture foil must be treated correctly. Some suggested techniques are given and examples are presented of studies using the Columbia synchrocyclotron neutron velocity spectrometer. Standard analysis curves are presented which illustrate the various points. Author

N67-18813# Oak Ridge National Lab., Tenn.
NEUTRON CROSS SECTIONS IN THE ENERGY RANGE 100 eV E_n<100 keV: RECENT PROGRESS, CURRENT STATUS, FUTURE OUTLOOK
J. H. Gibbons *In* EAC Neutron Cross Sect. Technol. Mar. 1966 p 404–429 refs Sponsored by AEC (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

The technology of measuring cross sections in the energy range 100 eV<E_n<100 keV has advanced significantly over the past several years. The most notable developments have occurred in detectors for capture cross section measurements, available neutron energy resolution in general, and absolute values for flux normalization. Reactor design needs for total and capture cross sections can apparently be met with existing or feasible equipment.

The primary exceptions to this statement are highly radioactive materials and some of the higher accuracy requests. Reaction theory and measured reaction systematics are insufficiently understood to enable more than an educated guess at unmeasured capture cross sections. Author (NSA)

N67-18815# Los Alamos Scientific Lab., N. Mex.
CROSS SECTIONS FOR NUCLEOSYNTHESIS IN STARS AND BOMBS
George I. Bell *In* AEC Neutron Cross Sect. Technol. Mar. 1966 p 454–472 refs Sponsored by AEC (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

We consider three different processes in which nuclei are synthesized by the multiple capture of neutrons with energies in the keV range, namely the s-process and r-process in stars, and the synthesis of very heavy nuclei in thermonuclear explosions. It is shown how the knowledge of neutron capture cross sections for s-process nuclei can clarify such features of the s-process as elemental abundances, time scales, and temperatures. For heavy element synthesis, more data is needed on capture to fission ratios, particularly for odd-odd nuclei. Author

N67-18816# Brookhaven National Lab., Upton, N. Y.
THE NEUTRON CROSS SECTION OF SODIUM BELOW 40 KeV
Thomas E. Stephenson *In* AEC Neutron Cross Sect. Technol. Mar. 1966 p 473–485 refs Sponsored by AEC (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

The neutron cross section of sodium from 1 eV to 40 keV is calculated. A good fit to the data is obtained with the spin-dependent scattering radii $R_+^1 = 5.85$ f and $R_-^1 = 5.18$ f. A good fit is not found using a spin-independent scattering radius. The excess absorption resonance integral is calculated to be 0.072 barns and is in good agreement with experimental values. The scattering resonance integral is calculated to be 72 barns which compares favorably with an evaluated experimental result. The low energy potential scattering is described by spin-dependent square potential wells. Author (NSA)

N67-18817# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
BORON CROSS SECTIONS AS A SOURCE OF DISCREPANCY FOR CAPTURE CROSS SECTIONS IN THE keV REGION
Donald Bogart *In* AEC Neutron Cross Sect. Technol. Mar. 1966 p 486–501 refs (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

Discrepancies in capture cross sections for gold from 80 to 200 keV are explained by changes in boron (n,α) cross sections used to monitor neutron fluxes. These changes in boron cross sections are shown to improve agreement in capture data for iodine, indium, silver, antimony, and tantalum. Reexamination of the boron cross section measurements discloses that a modified long counter with considerable loss in efficiency below 200 keV had been used, but its response had been taken to be flat. Boron cross sections, corrected for long counter efficiency, depart significantly from a 1/v variation above ≈80 keV. Author

N67-18818# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
MONTE CARLO INTERPRETATION OF SPHERE TRANSMISSION EXPERIMENTS FOR AVERAGE CAPTURE CROSS SECTIONS AT 24 keV
Donald Bogart and Thor T. Semler *In* AEC Neutron Cross Sect. Technol. Mar. 1966 p 502–521 refs (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65

Monte Carlo analyses of sphere transmission experiments at 24 keV are made using statistical results from slow neutron resonance spectroscopy as input data. An average capture cross section $\bar{\sigma}_C$ for gold of 700±50 mb is obtained compared with a reported value of 532±60 mb evaluated by a widely used multiple scattering analysis. A small p-wave contribution is required for gold. For iodine s-wave and p-wave contributions of 442±50 mb and 358±60 mb, respectively, provide a $\bar{\sigma}_C$ of 800±80 mb. This is in substantial agreement with a reported value of 768±90 mb. For nuclei with large s-wave scattering, such as gold, the usual multiple scattering analysis is shown to encounter difficulties because of ambiguity as to the effective scattering cross section to be used. Author

N67-18820# Atomics International, Canoga Park, Calif. IIT Research Inst., Chicago, Ill.
NEUTRON FLUX SPECTRAL DETERMINATION BY FOIL ACTIVATION
W. N. McElroy, S. Berg, and G. Gigas *In* AEC Neutron Cross Sect. Technol. Mar. 1966 p 532–553 refs Prepared for IIT Res. Inst. (See N67-18781 08-22) CFSTI: HC $3.00/MF $0.65 (Contract AF 29(601)-6780)

An advanced analytical technique has been applied to several different types of neutron environment to obtain neutron flux spectra. The mathematical procedure involves selection of an initial spectral approximation and its subsequent perturbation to obtain a best fit simultaneous solution for a system of ten or more activation integral equations. The present analytical studies support earlier results that integral neutron flux may be obtained from foil data with accuracies to within ±10 to 30% at any point over the energy range from 4×10^{-7} to 18 MeV. If the activation cross section data and measured activation rates are accurate to ±10%. Author

N67-18823# Duke Univ., Durham, N. C.
RESONANCE STRUCTURE ABOVE 100 KeV
H. W. Newson *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 562–576 refs (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

From about 100 to 1,000 KeV, resolutions already attained are sufficiently good to distinguish and measure the parameters of s- and p-wave resonances for Pb^{206}, Pb^{208} and lighter even-even (nearly isotopically pure) targets as heavy as A = 70. The results of such analysis are consistent with the Porter–Thomas and Wigner distributions, the sum rule for "doorway states", the supershell models of Rosenzweig and of Newson and Duncan, and the (2J+1) rule as applied to s-, p-, and possibly d-wave resonances. Recent results of strength function measurements from averaged cross sections are discussed. The s-wave strength functions still appear to be unexpectedly low in the neighborhood of tin. The p-wave strength functions between A = 75 and 140 are in reasonably good agreement with the vibrating nucleus calculations of Buck and Perey. Author

N67-18824# Argonne National Lab., Ill.
INELASTIC NEUTRON SCATTERING: A COMPENDIUM
A. B. Smith *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 577–598 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

Inelastic neutron scattering is considered primarily in a technological context. Pertinent experimental methods including non-elastic, (n-n'γ), and time of flight techniques are discussed with emphasis on present capabilities and future potential. The present state of experimental knowledge is illustrated by inelastic scattering from Al, Fe, and U. Consideration is given to the inelastic excitation of both discrete nuclear states and states forming part of the nuclear continuum. The physical interpretation of the experimental results is discussed within the framework of the

optical model and Hauser–Feshbach theory including effects due to deformation and resonance width fluctuations. Predictions based upon a general optical potential are compared with a wide range of measured inelastic cross sections and it is shown that the potential provides a mechanism for extrapolating the experimental results. Finally, the effect of improved knowledge of inelastic scattering on macroscopic reactor calculations is illustrated. Author

N67-18825# Texas Nuclear Corp., Austin.
GAMMA RAY PRODUCTION CROSS SECTIONS IN (n,n'γ) REACTIONS AND COMPARISON TO SATCHLER THEORY CALCULATIONS
I. L. Morgan, S. C. Mathur and D. O. Nellis *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 599–612 refs 1966 p 599–612 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

A systematic program of experimental measurements of gamma ray production due to (n,n'γ) reactions has been developed. The experimental distributions have been compared with the predictions of the Satchler theory for twelve nuclei with mass numbers ranging from 24 to 208. The results indicate that the Satchler theory predicts reasonably the anisotropies and the cross sections for nuclei over a wide range of mass numbers, shell structures and incident neutron energies in the range 1–5 MeV. Some discrepancies have been observed in the region of threshold and may be attributed to cross section fluctuations. The gamma ray production cross sections are required in reactor design, radiation shielding and nuclear theory. However, in many cases, the experimental determination of these cross sections is impractical due to low natural abundance of the nuclear species, low gamma ray yield, and complex gamma ray spectra. In such cases, these cross sections may be calculated on the basis of Satchler theory if the detailed information on the energy levels and their spin and parities is available. Computer programs have been developed at this laboratory to perform these calculations. Author

N67-18826# Argonne National Lab., Ill.
EFFECTS OF (n,γn') PROCESSES ON FAST NEUTRON CAPTURE AND NON-ELASTIC SPECTRA
P. A. Moldauer *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 613–622 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

An initial gamma-ray de-excitation of the compound nucleus is followed by neutron re-emission with increasing likelihood as the incident neutron energy rises above 1 MeV. This fact plays a major role in determining the energy dependence of the capture cross section at neutron energies above 1 MeV. It also provides an important mechanism for fast neutron energy degradation that supplements inelastic scattering. The magnitudes of these effects are estimated with the aid of statistical models of the compound nucleus for iron, tantalum, thorium, and U^{238}. Author

N67-18827# Los Alamos Scientific Lab., N. Mex.
RELATIVE FISSION CROSS SECTIONS OF ^{238}U, ^{237}Np, AND ^{236}U
W. E. Stein, R. K. Smith, and J. A. Grundl *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 623–633 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

Fission cross-section ratios $^{238}U/^{235}U$ and $^{237}Np/^{235}U$ have been measured with pulsed, monoenergetic neutrons in the energy range 1.0 to 5.0 MeV with time-of-flight background discrimination. Vacuum evaporated fissile deposits (≈ 0.5 mg/cm^2) were placed back to back between two 9.5 cm^2 surface barrier detectors. Slow and fast output signals were obtained simultaneously from each detector by means of separate electronic systems. Slow, linear pulses which exceeded a lower bound set to reject alpha particles were identified as fission events. The fraction of fragment pulses below this bias, determined from an extrapolation of the pulse-height spectrum, was ≈1.2%. Only those fission events which occurred during and a few nanoseconds after the neutron burst were recorded. This time interval, determined by the measured time resolution (1.3 nsec FWHM) and the time walk of the smallest pulses (≈2 nsec), was typically 10 nsec. events induced by scattered neutrons which occur at later times were excluded. Characteristics of this detector and electronic system are presented along with the measured cross-section ratios. Author (NSA)

N67-18828# Los Alamos Scientific Lab., N. Mex.
ELASTIC AND INELASTIC SCATTERING OF FAST NEUTRONS FROM ^6Li AND ^7Li
John C. Hopkins *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 634–643 refs (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

The differential elastic and inelastic neutron scattering cross sections of ^6Li and ^7Li have been measured at six scattering angles with an incident neutron energy of 4.83 MeV for ^6Li, and with energies of 3.35 and 4.83 MeV for ^7Li. Scattered neutrons and gamma rays were observed independently. The neutron cross sections were measured with a neutron time-of-flight spectrometer relative to the well-known cross section for neutron scattering from hydrogen. The gamma-ray spectra were measured with a NaI(T1) spectrometer, using time-of-flight techniques to eliminate the neutron background. The 2.184 MeV state in ^6Li was excited by neutron inelastic scattering and wse observed not to decay by gamma-ray emission. Scattered neutrons from the 0.478 MeV state in ^7Li were resolved at both incident neutron energies. A continuum of neutrons due to three particle breakup was observed from both ^6Li and ^7Li at 4.83 MeV. Author (NSA)

N67-18829# California Univ., Livermore. Lawrence Radiation Lab.
NEUTRON CROSS SECTIONS INFERRED FROM CHARGED PARTICLE DATA
H. F. Lutz and J. D. Anderson *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 644–652 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

The possibility of using charged particle data together with various nuclear models to generate neutron data is explored. A general description of the interaction of nucleons with matter in terms of specific models (optical model, extended optical model, charge independence and charge symmetry) is presented, along with enough data to indicate their general usefulness in generating neutron cross sections. As a specific example light nuclei are dealt with, and we present in detail the application of charge symmetry anc charge independence. Author

N67-18830# Oak Ridge National Lab., Tenn.
DIFFERENTIAL ELASTIC SCATTERING OF NEUTRONS FROM NITROGEN
J. L. Fowler, C. H. Johnson, and R. L. Kernell *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 653–659 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

Differential cross sections were measured at energies between 1.595 and 3.207 MeV. A detailed discussion of the results is presented. NSA

N67-18832# General Dynamics/Fort Worth, Tex.
THE 14-MeV DIFFERENTIAL CROSS SECTION OF NIOBIUM 93
G. T. Western, J. R. Williams, and H. G. Carter *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 675–681 refs (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

The differential elastic cross section of Nb^{93} for 14-MeV neutrons has been measured by the associated particle time-of-flight

method at angles from 20° to 140°. Extrapolation using the black-core model yields a total elastic cross section of 1770 mb. The measured total cross section is 3940 mb. The substantial difference between the total-minus-elastic value of 2170 mb and the reported, measured "non-elastic" value of 1750 mb for Zr is considered. It is concluded that the contribution of the direct interaction component is appreciably higher than the 10% generally attributed to it. Author

N67-18833# General Dynamics/Fort Worth, Tex.
DISCREPANCY BETWEEN EXPERIMENTAL AND PREDICTED CROSS SECTIONS FOR THE $Nb^{93}(n,2n)Nb^{92}$ REACTION
H. G. Carter *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 682–689 refs (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

The 14 MeV (n,2n) cross section of Nb^{93} measured by activation analysis is much smaller than the value predicted by statistical model theory. In order to locate the origin of the discrepancy we have analyzed the prompt gamma yield and found it to be consistent with the statistical model predictions, although it appears that the competition from the (n,np) process is stronger than expected. The (n,2n) discrepancy is explained in terms of the formation of an Nb^{92} isomer with an unobservable activity. Author

N67-18834# Rensselaer Polytechnic Inst., Troy, N. Y.
MeV TOTAL CROSS SECTIONS WITH THE RENSSELAER LINAC
P. F. Yergin, R. C. Martin, E. J. Winhold, H. A. Medicus, W. R. Moyer et al *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 690–700 (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65
(Contract AT(30-3)-328)

The Rensselaer electron linac has been used to measure MeV neutron total cross sections of a number of nuclides. Bursts of 90 MeV electrons of < 10 nsec duration on a composite B_4C and W target produce a broad neutron spectrum which is analyzed by time of flight. Collimation diameters of 3", 2", and 0.22" have been used. With the smallest diameter, separated isotope samples can be used. Overall time resolution is now about 0.24 nsec/m, and will soon be reduced to 0.05 nsec/m or better. The high intensity of the linac beam permits rapid data accumulation even with the smallest collimator. Typically, 3 percent statistics can be obtained at each of 2000 data points from a total of 3 hours running time. Useful data is obtained from 0.4 to 45 MeV. Author

N67-18835# Argonne National Lab., Ill.
MEASUREMENT OF THE $Li^6(n,\alpha)$ and $B^{10}(n,\alpha)$ CROSS SECTIONS BY THE SHELL TRANSMISSION METHOD
Samson A. Cox *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 701–712 refs Sponsored in part by AEC and United Kingdom Atomic Energy Authority (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

The spherical shell transmission method was used to measure the total neutron absorption cross section for Li^6 from 10.7 keV to 102. keV and for B^{10} from 10.7 keV to 245. keV. Measurements were made with the neutron source inside the spherical shell and detector outside and with the neutron source outside and detector inside. The $Li^7(p,n)$ reaction was utilized as the neutron source inside the spherical shell. For the measurements with the neutron source inside the spherical shell 7 moderated BF_3 counters were placed around the sphere to effectively integrate over the angular distribution of the neutrons from the $V^{51}(p,n)$ reaction and thus to compensate for any anisotropy. After correction for finite size effects and multiple scattering, the results of the two methods were in good agreement. The final cross section for the B^{10} measurements were in good agreement with a 1/v extrapolation from a thermal neutron absorption of 3840 barns. The final cross section for Li^6 was ≈30% higher at 10.7 keV than a 1/v extrapolation from ther thermal cross section of 945 barns. Author

N67-18836# California Univ., Livermore. Lawrence Radiation Lab.
THE (n,2n) REACTION INDUCED BY 14.5 MeV NEUTRONS
Donald G. Gardner *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 713–725 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

With a statistical-model approach the ratios of the cross sections for the (n,2n) reaction on adjacent isotopes of all elements in the range $30 \leq Z \leq 83$ have been computed as a function of energy. These ratios have been semiempirically normalized at 14.5 MeV to obtain predictions of absolute (n,2n) cross sections. This approach is compared with other methods for computing (n,2n) cross sections, and with available experimental data. The use of (p,2n) and (α,2n) cross sections to evaluate the importance of pairing effects is illustrated. Also, a few excitation functions are computed and compared with experimental data. Author

N67-18837# Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering.
MEASUREMENT OF NONELASTIC CROSS SECTION FOR LEAD AT 2.1 AND 1.7 MeV
L. E. Beghian, F. Hofmann, and S. Wilensky *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 726–734 refs (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

A new method has been developed to measure total nonelastic neutron cross sections in the high keV and low MeV energy range. A pulse of monoenergetic fast neutrons of several nanoseconds duration is used to excite a lead assembly. The neutron decay is measured as a function of assembly size with conventional nanosecond time of flight equipment. The neutron detector is biased to eliminate all nonelastically scattered neutrons. A theoretical relationship has been developed which relates the assembly size to the measured decay constant. Decay constants were measured at 2.1 and 1.7 MeV for lead assemblies 20" wide × 20" high and thicknesses from 1" to 8". Peik's theory assumes the establishment of an asymptotic special decay mode. This assumption was verified by measuring the neutron decay at various positions of the assembly. The results show that it takes the order of 10–15 ns to establish a special mode. Author

N67-18839# Los Alamos Scientific Lab., N. Mex.
GAMMA-RAY PRODUCTION CROSS SECTIONS OF FAST NEUTRON-INDUCED REACTIONS IN Al, Fe, Nb, W, U, AND Pu.
Henri Conde, Darrell M. Drake, and John C. Hopkins *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 735–741 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

Differential cross sections for gamma-ray production by fast neutrons are being measured for Al, Fe, Nb, W, U-235, and Pu-239 with neutrons in the energy range from 3.5 to 7.5 MeV. Use is made of a NaI(Tl) spectrometer surrounded by a large NaI(Tl) anticoincidence shield. The efficiency and the energy resolution of the spectrometer were determined with calibrated gamma-ray sources. The resolution of the 0.66-MeV gamma rays from Cs-137 is about 9%. Gamma rays between 100 keV and 7 MeV are detected. Nanosecond time-of-flight techniques are used to eliminate the neutron background. An online computer, employed as a two-dimensional pulse-height analyzer, records and displays time versus energy. The time resolution of the gamma rays without correction for rise time effects is about 3 nsec. Preliminary results for the relative cross sections are given for Al. Author

N67-18839# Lockheed Missiles and Space Co., Palo Alto, Calif. Research Lab.
ISOMERIC CROSS-SECTION RATIOS FROM FAST-NEUTRON CAPTURE
H. A. Grench *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 742–745 refs (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

The study of isomeric cross-section ratios has been shown to be a useful means of determining the spin-cutoff factor which appears in the expression for the spin dependence of the nuclear level density. This factor is of theoretical interest since it can be related to an effective nuclear moment of inertia. In addition, its magnitude is of importance in statistical-model calculations of fast-neutron-capture cross sections. The present work is an extension of fast-neutron capture of an earlier treatment of thermal-neutron-capture isomer ratios. Particular attention is given to an analysis of the $Y^{89}(n,\gamma)Y^{90m,90g}$, $In^{113}(n,\gamma)In^{114m,114g}$, and $In^{115}(n,\gamma)In^{116m,116g}$ cross sections previously measured in this laboratory. Author

N67-18840# Lockheed Missiles and Space Co., Palo Alto, Calif.
FAST NEUTRON CROSS SECTIONS FOR THE $Na^{23}(n,\gamma)Na^{24}$, $Mn^{55}(n,\gamma)Mn^{56}$, $In^{115}(n,\gamma)In^{116m}$ AND $Ho^{165}(n,\gamma)Ho^{166}$ REACTIONS
H. O. Menlove, K. L. Coop, H. A. Grench, and R. Sher *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 746–752 refs (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

Neutron capture cross sections of Na^{23}, Mn^{55}, In^{115}, and Ho^{165} have been measured by activation techniques at 16 neutron energies between approximately 1.0 and 19.5 MeV. Neutrons were produced by means of the $T(p,n)He^3$, $D(d,n)He^3$, $Be^9(\alpha,n)C^{12}$, and $T(d,n)He^4$ reactions using the Lockheed 3.5-MV Van de Graaff accelerator. The measurements were relative to the fission cross section of U^{235} for fast neutrons. A thermal irradiation was made in order to obtain cross sections normalized to the thermal activation cross sections of the irradiated samples and the thermal fission cross section of U^{235}. The experimental cross section data show evidence of a peak in the vicinity of 15 MeV. Author

N67-18841# Laboratories du Centre d'Etude de l'Energie Nucleaire, Mol (Belgium).
SPIN MEASUREMENT OF THE 8.8 eV NEUTRON RESONANCE IN U^{235} BY MEANS OF THE RESONANT SCATTERING METHOD
F. Poortmans, H. Caulemans, M. Neve de Mevergnies *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 755–762 refs (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

Because of the usually small Γ^0_n values of low energy resonances in fissile isotopes a special scattering chamber has been constructed using a He^3 proportional counter (2 inch diameter, 50 cm length and 10 atm. pressure), for which a pulse-height discrimination is possible between fission neutrons and scattered neutrons. Scattering measurements in the 8.8 eV resonance of U^{235} yield as preliminary result J = 3. Author

N67-18842# Atomic Weapons Research Establishment, Aldermaston (England).
CROSS SECTION FOR THE REACTION $Li^6(n,\alpha)T$
J. F. Barry *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 763–765 refs (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

The cross section for the reaction $Li^6(n,\alpha)T$ has been measured relative to the fission cross section for U^{235} at neutron energies of 25, 67 and 100 keV. The ratio of the count rates in a fission chamber and a lithium-loaded ionization chamber was determined when the counters were simultaneously exposed to a flux of neutrons. Determination of this ratio for thermal neutrons, for which both the $Li^6(n,\alpha)$ and U^{235} fission cross sections are known, enables cross sections to be obtained which are independent of the mass of material in either counter. The results help to distinguish between previous determinations of the cross section in this energy region. Author

N67-18843# Los Alamos Scientific Lab., N. Mex.
MEASUREMENTS ON THE CAPTURE CROSS-SECTION OF U^{238} WITH BOMB SOURCE NEUTRONS
N. W. Glass, J. K. Theobald, A. D. Schelberg, J. H. Warren, and L. D. Tetro *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 766–772 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

Measurements of the neutron capture cross-section of U^{238} by neutron time-of-flight utilizing the pulse source of neutrons from a nuclear device have been made on the Parrot and Petrel underground shots at the Nevada Test Site. The neutron flight path was approximately 200 meters. Three U^{238} samples of 200, 200, and 16.6 barns/atom, respectively, were in the beam and viewed by a variety of Moxon–Rae type photomultiplier and solid-state detectors, resulting in a self-indication type of measurement from which resonance parameters can be derived for resonances from 36.7 eV to ≈2000 eV. Experimental details, data recording techniques, and results will be described. Author (NSA)

N67-18849# Phillips Petroleum Co., Idaho Falls, Idaho.
MEASUREMENT AND ANALYSIS OF CROSS SECTIONS OF FISSILE NUCLIDES
M. S. Moore and O. D. Simpson *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 840–872 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

A review is given of developments which have led to more accurate measurements of total and partial cross sections of fissile nuclides. Recent experiments which provide a more complete understanding of the fission process are also discussed. Calculations are performed to compare observed resonance behavior of ^{241}Pu with resonances whose parameters are generated by a Monte-Carlo treatment based on fission theory. Author

N67-18850# Atomic Energy Commission, Washington, D. C.
INTERPRETATIONS OF NEUTRON CROSS SECTIONS OF THE FISSIONABLE MATERIALS FOR THE RESOLVED RESONANCE REGION
F. T. Adler and D. B. Adler *In its* Neutron Cross Sect. Technol. 24 Mar. 1966 p 873–894 refs (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

The relations of various well-known formalisms in nuclear theory are considered. Certain advantages of the Kapur-Peierls formalism for a description of low energy cross sections of fissile nuclides in a form suitable for applications in practical reactor calculations are considered. Author

N67-18851# Los Alamos Scientific Lab., N. Mex.
THE FISSION CROSS SECTION OF ^{233}U, 20 eV–2MeV
D. W. Bergen M. G. Silbert, and R. C. Perisho *In* Neutron Cross Sect. Technol. 24 Mar. 1966 p 895–902 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

Data are presented on the fission cross section of ^{233}U over the energy range from 20 eV to 2 MeV. These data were obtained in June, 1965 by exposing a thin target of ^{233}U to neutrons originating from an underground nuclear detonation. The data show resolved individual resonances from 20 eV to about 100 eV and resonance structure to above 1 keV. The low background and and good energy resolution inherent in this experiment provide an improved peak-to-valley ratio compared to previously reported data. Author (NSA)

N67-18852# Los Alamos Scientific Lab., N. Mex.
CAPTURE AND FISSION CROSS SECTIONS OF ^{240}Pu
D. H. Byers, B. C. Diven, and M. G. Silbert *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 903–909 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

The capture and fission cross actions of ^{240}Pu are presented in the energy interval 20 eV to 2 MeV. The results were obtained using the technique of neutron cross section measurement by the time-of-flight method employing a nuclear detonation as the pulsed neutron source. Author

N67-18853# Phillips Petroleum Co., Idaho Falls, Idaho.
THE FISSION CROSS SECTION OF ^{241}Pu FROM 20–200 eV AS DETERMINED FROM A NUCLEAR EXPLOSION
O. D. Simpson, R. G. Fluharty, M. S. Moore, and N. H. Marshall *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 910–918 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

A nuclear explosion has been used as a neutron source for a measurement of the neutron-induced fission cross section of ^{241}Pu. Over the region from 20 to 200 eV, the region of thermal neutron energies of the source, the flux was high enough to permit the determination of fission cross sections with a minimal error. A comparison of these data with previous measurements of the fission cross section of ^{241}Pu shows that a significant improvement has been made, both in resolution and in statistical accuracy. The data below 60 eV have been analyzed with the use of a multilevel formula. Author (NSA)

N67-18854# Phillips Petroleum Co., Idaho Falls, Idaho.
TECHNIQUES FOR DETERMINING ETA FOR THE THERMALLY FISSIONABLE ISOTOPES
J. Richard Smith and Edwin Fast *In* AEC Neutron Cross Sect Technol. 24 Mar. 1966 p 919–932 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

Several types of experiments are reviewed as to their contributions to an understanding of the fission parameter η, the number of fission neutrons produced per absorption. The comparison of monochromatic values with spectrum-averaged values required detailed understanding of the energy dependence involved. It is necessary to consider all evidence concerning both absolute value and energy dependence in order to obtain a consistent picture of either. Author

N67-18855# Atomic Weapons Research Establishment, Aldermaston (England).
MEASUREMENTS AND CALCULATIONS OF THE DOPPLER EFFECT ON THE REACTION ^{238}U(n,γ), ^{235}U(n,f) AND ^{239}Pu (n,f) with NEUTRONS IN THE ENERGY RANGE 0–25 KeV
J. L. Perkin, P. Fieldhouse, A. Brickstock, and A. R. Davis *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 933–938 refs (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

Spherical samples, 2 cm in diameter, of U^{238}, U^{235}, and Pu^{239} were irradiated in turn at various temperatures ranging from 170 to 770°K in a central cavity of a spherically symmetrical Sb-Be photo neutron source. The U^{238}(nγ) reaction rate was measured by counting the U^{239} activity produced and the (n,f) reactions were monitored by counting the fission neutrons emitted. The results obtained for the dependence of reaction rate on temperature were compared with those from a computer calculation based on a programme developed by Brisseendon and Durston. Author

N67-18856# Los Alamos Scientific Lab., N. Mex.
FISSION CROSS SECTION OF ^{239}Pu, 20 eV TO 2 MeV
Edward R. Shunk, W. K. Brown, and R. La Bauve *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 978–984 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

The fission cross section of ^{239}Pu has been measured by time-of-flight using neutrons from an underground nuclear explosion. The Petrel event in June, 1965 at the Nevada Test Site provided an extremely high neutron flux from 20 eV to 2 MeV. The neutron flux was determined from simultaneous measurement of ^{6}Li(n,α) for E<100 keV, and ^{235}U(n,f) for E>10 keV. Backgrounds were measured by recording signals from blank backing foils. Author (NSA)

N67-18860# Phillips Petroleum Co., Idaho Falls, Idaho.
ANALYTICAL DESCRIPTIONS OF THE SUB-CADMIUM CROSS SECTIONS OF ^{233}U, ^{235}U, ^{239}Pu, AND ^{241}Pu
R. G. Fluharty, N. H. Marshall, and O. D. Simpson *In its* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 985/998 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

Simple analytical fits to the absorption and fission neutron cross sections for the fissile nuclei are presented below 0.5 eV. The coefficients of the mathematical equations are presented and should be of interest to those calculating reactor reaction rates. Author

N67-18861# Argonne National Lab., Ill.
A COMPARISON OF MULTILEVEL AND SINGLE LEVEL EFFECTS OF A FISSIONABLE ISOTOPE
E. M. Pennington *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 997–1003 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

A study was made of the behavior of the total and fission cross sections of two neighboring resonances, calculated using various sets of parameters in multilevel formulae. Least-squares fits of single level cross sections to the multilevel cross sections were performed. If the separation of the resonances is approximately greater than the sum of their widths, it is generally possible to obtain single level parameters which will yield infinite dilution capture and fission resonance integrals in reasonable agreement with multilevel values. For closer spacings, two resonances may appear to be one, and the fitting often becomes unsatisfactory. Author

N67-18862# California Univ., Livermore. Lawrence Radiation Lab.
THE EPITHERMAL FISSION CROSS SECTION OF U^{235}
C. D. Bowman, G. F. Auchampaugh, S. C. Fultz, M. S. Moore, and F. B. Simpson *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 1004–1012 refs (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

The neutron-induced fission cross section of U^{235} has been remeasured over the energy range from 0.02 to 80 eV with the Livermore linear electron accelerator as the pulsed neutron source for a time-of-flight experiment. The fission events were detected in the ionization chamber containing a total of 3/4 g of U^{235}, the flux was monitored with a BF 3 tube placed in the same flight path. The cross section was normalized at thermal energy. The results are compared with earlier Livermore work and with other recent measurements. Author

N67-18863# Los Alamos Scientific Lab., N. Mex.
A METHOD OF ASSAY OF ^{236}U, ^{238}U, AND ^{237}Np FISSION FOILS
H. L. Smith and J. P. Balagna *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 1013–1022 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

A combination of 2π and low geometry α counting was used to assay a set of vacuum-evaporated ^{235}U, ^{238}U, and ^{237}Np foils to be used in the measurement of their relative high-energy neutron fission cross sections. The masses assigned to the uranium foils rest on experimentally determined specific α activities; the neptunium masses depend on low geometry counting and the published half-life. Author

N67-18865# Rensselaer Polytechnic Inst., Troy, N. Y. Nuclear Engineering and Science Dept.

FUTURE TRENDS IN CROSS SECTION WORK WITH ELECTRON LINACS

E. R. Rae *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 1035–1050 refs (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

(Contract AT(30-3)-328)

This paper summarises the present status of neutron time of flight spectroscopy using electron linacs as pulsed neutron sources, and attempts to forecast probable lines of development over the next few years. The first half of the paper is concerned with pulsed sources and instrumentation, including electronics and data handling methods. The second half deals with experimental methods, new and improved detection techniques, extension of existing techniques to a wider energy range and greater accuracy, and the probable result of these improvements in terms of nuclear data. Author

N67-18866# Los Alamos Scientific Lab., N. Mex.

USE OF NUCLEAR EXPLOSIONS AS PULSED NEUTRON SOURCES

Benjamin C. Diven *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 1051–1054 Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

Nuclear explosions have been developed as neutron sources for time-of-flight experiments. These sources are especially useful for measurements on highly radioactive samples, materials with short lives, and for substances for which only very small samples can be obtained. Author

N67-18867# Oak Ridge National Lab., Tenn.

PROTON ACCELERATORS AS SOURCES OF SLOW NEUTRONS

A. Zucker *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 1055–1063 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

Proton accelerators in the 50 MeV to 1 BeV range are examined as sources of pulsed neutrons. Figures of merit are given for the isochronous cyclotron and the synchrocyclotron. Under present operating conditions they are 4.8×10^{29} and 2.4×10^{28} respectively. By raising the energy and with other improvements the figure of merit for an isochronous cyclotron can reach 2×10^{32}, while for a synchrocyclotron it approaches 4.3×10^{30}. The separated orbit cyclotron compared on the same basis has a figure of merit equal to 1.8×10^{33}. The figure of merit is defined as the number of neutrons per second produced in a pulse, divided by the pulse width, and multiplied by the repetition rate. Author

N67-18868# Argonne National Lab., Ill.

A NEW APPROACH TO NEUTRON RESONANCE SPECTROSCOPY

L. M. Bollinger *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 1064–1072 Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

The use of bremsstrahlung to study highly excited nuclear states of heavy nuclides by means of the (γ,n) reaction is discussed. In the proposed experiments neutron time-of-flight spectra give information about states just above the neutron binding energy, the states now studied only by neutron-induced reactions. An effective accelerator for this purpose is an FN Tandem that accelerates electrons from a source in the terminal. Detailed considerations show that (γ,n) measurements are much more effective than neutron cross section measurements for obtaining additional information concerning the statistical properties of nuclear energy levels. Author

N67-18870# New York Univ., N. Y.

PROPOSED RECOIL TECHNIQUE FOR NEUTRON-PROTON DIFFERENTIAL CROSS SECTION MEASUREMENTS IN THE 15–30 MeV RANGE

R. E. Benenson and W. Patton (Columbia Univ.) *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 1084–1091 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

A method is described for employing a single well-shielded counter for the simultaneous recording of a continuous distribution of recoil angles from a thin radiator. Angles are inferred from the $\cos^2\theta_0$ angle–energy relation through pulse heights in a high resolution solid state detector. Recoil trajectories are caused to converge onto the detector by means of a nearly uniform magnetic field in which the radiator is placed. The possible advantages of such a system are discussed, analytical and graphical methods for specifying the specially shaped pole edges are described, and some practical details of magnet fabrication are mentioned. Author

N67-18871# Argonne National Lab., Ill.

LOW FLUX DETERMINATION OF CAPTURE-TO-FISSION RATIO

W. C. Redman and M. M. Bretscher *In* AEC Neutron Cross Sect. Technol. 24 Mar. 1966 p 1092–1097 refs Sponsored by AEC (See N67-18821 08-24) CFSTI: HC $3.00/MF $0.65

A novel method which makes possible a direct measurement in low power reactors of the effective capture-to-fission ratio, α, has been developed. It involves a comparison of reactor response to oscillated samples of a fissile material, an absorber and a spontaneous fission source, augmented by an experimental determination of the respective fission rate, capture rate, and neutron source strength. These experimental results, combined with the number of neutrons per fission of the fissile material, yield a value for the quantity $1+\alpha$. Applications of this technique are illustrated by the results for measurements with U^{235} in both an undermoderated critical assembly of moderately enriched U^{235} in light water and an epithermal, 1/E neutron spectrum. Author

N67-18877# Midwestern Universities Research Association, Stoughton, Wis.

ANALYTICAL CALCULATION OF FFAG OPERATING POINTS AND ORBITS

C. S. Chien 28 Apr. 1966 32 p refs

(Contract W-31-109-38-1707)

(MURA-719) CFSTI: HC $3.00/MF $0.65

Among the reports on an analytic description of particle motion in FFAG accelerators, the specific case of an integral structure machine is not treated in sufficient detail to yield quantitative conclusions starting from a set of general field coefficients. In parallel with computer studies, an analytical investigation of the unperturbed differential equations of a charged particle motion in a steady magnetic field was made. A special technique is developed to yield the exact solution (in terms of power series) of the nonlinear equation of motion in the median plane. Based on the results of the equilibrium orbits, betatron oscillation frequencies are obtained by the application of second-order perturbation theory of quantum mechanics. An analytical method was programmed for the IBM 704 computer. A typical operating time of six minutes yields the betatron oscillation frequencies. Author (NSA)

N67-18878# Oak Ridge National Lab., Tenn.
X-RAY DIFFRACTION DATA ON LIQUID WATER IN THE TEMPERATURE RANGE 4 TO 200°C
A. H. Narten, M. D. Danford, and H. A. Levy Sep. 1966 154 p refs
(Contract W-7405-ENG-26)
(ORNL-3997) CFSTI: HC $3.00/MF $0.65

The scattering of X-rays from the free surface of liquid water in equilibrium with water vapor was measured and analyzed at 4°, 25°, 50°, 75°, 100°, 150°, and 200°C. Deuterium oxide at 4°C was also studied. The diffractometer used was specially designed for the study of liquid samples. At each scattering angle, up to 600,000 counts were recorded to assure meaningful counting statistics, and data collection was extended to values of 18 in $s=(4\pi/\lambda)\sin\theta$. Both the raw data and the intensity and radial distribution functions derived from them are presented in tabulated form. The experimental radial distribution functions are in agreement with most of the previously published work on water, showing, however, much higher resolution. They show deviations from a uniform distribution of distances out to 8 Å at room temperature, and significant but gradual changes occur with increasing temperature. Author (NSA)

N67-18879# Atomics International, Canoga Park, Calif.
OPTICAL-MODEL ANALYSIS OF SOME RECENT TUNGSTEN CROSS-SECTION MEASUREMENTS
Charles L. Dumford 15 Jul. 1966 97 p refs
(Contract AT(11-1)-GEN-8)
(NAA-SR-11973) CFSTI: HC $3.00/MF $0.65

Recent measurements of neutron scattering properties of the isotopes ^{182}W, ^{184}W, and ^{186}W in the energy region between 0.3 and 1.5 MeV were analyzed using a combined nonspherical optical model and improved compound nucleus theory. Significant improvements over previous calculations for tungsten in this energy region are noted and are discussed. Recommended microscopic cross-section information for the even–even tungsten isotopes over the energy range 0.3 to 1.5 MeV are presented. Some discussion of higher energy-interactions in the light of the present analysis is also presented. Author (NSA)

N67-18887# Idaho Nuclear Corp., Idaho Falls.
FISSION CROSS SECTION OF Pu-241 FROM 0.01 eV TO 0.5 eV
T. Watanabe Jul. 1966 14 p refs
(Contract AT(10-1)-1230)
(IN-1012) CFSTI: HC $3.00/MF $0.65

The fission cross section of ^{241}Pu was measured from 0.01 to 0.5 eV using the Materials Testing Reactor (MTR) fast chopper with a flight path of 4 meters. The fission events were detected by a gas scintillation fission chamber. Curves of $\sigma_f\sqrt{E}$ as a function of energy are given. Comparisons are made with previously measured fission cross sections. Author (NSA)

N67-18894# Stanford Univ., Calif. Linear Accelerator Center.
TABLES OF γ SPECTRA FROM e^+ HYDROGEN ATOM COLLISIONS
A. Dufner, S. Swanson and Y. Tsai Aug. 1966 135 p refs
(Contract AT(04-3)-515)
(SLAC-67) CFSTI: HC $3.00/MF $0.65

The theoretical values of the total cross sections for the annihilation processes: $e^+ + e^- \rightarrow 2\gamma$ and its radiative corrections and $e^+ + e^- \rightarrow 3\gamma$, and the differential cross sections for the bremsstrahlung processes: $e^+ + e^- \rightarrow e^+ + e^- + \gamma$ and $e^+ + p \rightarrow e^+ + p + \gamma$ are tabulated for fixed photon scattering angle and positron energy. The range of positron beam energy values is from 30 BeV to 0.50 BeV, for a variety of optimal scattering angles. A sufficiently dense spectrum of photon energies is given in each table to allow the application of graphing and numerical integration techniques for obtaining total bremsstrahlung cross sections at each photon scattering angle and initial positron energy value. The specific forms of the cross sections which were evaluated to produce the tables are discussed. Author (NSA)

N67-18895# Idaho Nuclear Corp., Idaho Falls.
NEUTRON RESONANCE ABSORPTION
W. A. Scheffler Sep. 1966 25 p refs
(Contract AT(10-1)-1230)
(IN-1021) CFSTI: HC $3.00/MF $0.65

An investigation of the solution to the slowing-down equations for a homogeneous mixture of substances is presented. The slowing-down equation can be reduced to a system of first-order differential equations under rather mild assumptions. The assumptions do not limit the physical phenomena associated with the resonance absorption. Flux oscillations and resonance shadowing are taken into account by the form of the solution. Furthermore, the solution is amenable to numerical calculation and has the same form as the exact solution for hydrogen. Author (NSA)

N67-18900# California Univ., Berkeley. Lawrence Radiation Lab.
HIGH ENERGY PARTICLE DATA. VOLUME II: RANGE-ENERGY AND dE/dx PLOTS OF CHARGED PARTICLES IN MATTER
W. Peter Trower 1 Jul. 1966 109 p refs
(Contract W-7405-ENG-48)
(UCRL-2426, Vol. II, Rev.) CFSTI: HC $3.00/MF $0.65

Range-energy and dE/dx graphs are plotted for various incident particles (alpha particles, electrons, muons, pions, kaons, hyperons, protons, and deuterons) in aluminum, argon, beryllium, carbon, copper, emulsion, helium, hydrogen, lead, lithium, nitrogen, oxygen, and silver. Included also is a section of supplemental data which contains information such as photon-mass absorption coefficient curves, and particle ranges in the liquid hydrogen bubble chamber. Author (NSA)

N67-18933*# National Aeronautics and Space Administration, Washington, D. C.
EXCITATION OF ATOMS BY ELECTRON BOMBARDMENT [VOZBUZHDENIYE ATOMOV ELEKTRONNYM UDAROM]
G. F. Drukarev and V. I. Ochkur Jan. 1967 11 p refs Transl. into ENGLISH from Russian Presented at the Intern. Union of Pure and Appl. Chem., and Acad. Sci. USSR, Intern. Symp. on Properties and Appl. of Low-Temp. Plasma, Moscow, 15–17 Jul. 1965
(NASA-TT-F-10691) CFSTI: HC $3.00/MF $0.65 CSCL 20H

A brief survey is presented of recent literature on the excitation probability of atoms by electron bombardment. Approximate formulas for the effective cross sections of atom excitation by electron bombardment are derived on the basis of simple considerations. The formulas are shown to yield cross section estimates of an accuracy of a factor of 1.5 to 3. Author

N67-18961*# Miami Univ., Coral Gables, Fla. Center for Theoretical Studies.
UNITARY REPRESENTATIONS OF U(2,2) AND MASSLESS FIELDS
Behram Kursunoglu Dec. 1966 23 p refs
(Contracts NGR-10-007-010; AF 49(638)-1260)
(NASA-CR-82369; CTS-HE-66-8) CFSTI: HC $3.00/MF $0.65 CSCL 20H

This paper contains a discussion of unitary irreducible representations of the group U(2,2) in terms of non-compact algebra of creation and annihilation operators and some applications to massless fields. In particular, the U(2,2) algebra yields discrete values for p_4 (energy), one of its generators. The little group and wave equations of massless fields are also derived from the Lie algebra of U(2,2). Author

N67-19016 California Univ., Berkeley. Lawrence Radiation Lab.
NUCLEAR REACTION Q-VALUES
C. Maples, G. W. Goth, and J. Cerny Jul. 1966 363 p refs
(Contract W-7405-ENG-48)
(UCRL-16964) CFSTI: $3.00

The results of some calculations of Q-values for gamma, nucleon, deuteron, triton, and ion reactions with nuclei from Z=2 to 92 are tabulated. NSA

N67-19020# Idaho Nuclear Corp., Idaho Falls.
NEUTRON ACTIVATION CROSS SECTIONS FOR THE Co^{60} ISOMERS
C. H. Hogg and L. D. Weber Aug. 1966 12 p refs
(Contract AT(10-1)-1230)
(IN-1024) CFSTI: HC $3.00/MF $0.65

The neutron activation cross sections of the two Co^{60} isomers were measured relative to that of Co^{59} with reactor neutrons. The thermal-neutron activation cross section for the 5.27-yr Co^{60} was measured to be 2.0±0.2 barns relative to 37 b for Co^{59}. The resonance integral is estimated to be 4.3 barns relative to 74 b for Co^{59}. The 10.4-min Co^{60m} thermal-neutron cross section and the resonance integral are 58±8 b and 230±50 b, respectively, relative to the Co^{59} values of 37 b and 74 b. The effect of these cross sections on the production of Co^{60} is small (10% during a 3-year irradiation period). R.L.

N67-19058# Argonne National Lab., Ill.
PHYSICS DIVISION Summary Report, May 1966
Lowell M. Bollinger May 1966 26 p refs
(Contract W-31-109-ENG-38)
(ANL-7218) CFSTI: HC $3.00/MF $0.65

A comparison was made of the relative spectroscopic factors from (^{3}He,d) reactions with those from (d,n) reactions for the low T=0 and T=1 states in the odd-odd nuclei ^{10}B, ^{14}N, and ^{26}Al. In each case a smaller value of the relative spectroscopic factor for the states with isobaric spin T=1 is deduced from the (d,n) reaction than from the (^{3}He,d) reaction, the spectroscopic factors being normalized to the T=0 ground states for the two reactions. NSA

N67-19059# Brookhaven National Lab., Upton, N. Y. Sigma Center.
NEUTRON CROSS SECTIONS. VOLUME IIA: Z=21 TO 40
Murrey D. Goldberg, Said F. Mughabghab, Benjamin A. Magurno, and Victoria M. May Feb. 1966 393 p refs
(Contract AT(30-2)-GEN-16)
(BNL-325, Suppl. 2, Vol. IIA) CFSTI: HC $3.00/MF $0.65

An updated compilation of thermal cross sections, resonance parameters, and cross-section curves is presented for elements and isotopes with Z=21 to 40. The reference sources are also included. NSA

N67-19143 California Univ., Berkeley. Lawrence Radiation Lab.
PHYSICS DIVISION SEMIANNUAL REPORT, NOVEMBER 1965–APRIL 1966
15 May 1966 71 p refs
(Contract W-7405-ENG-48)
(UCRL-16863) CFSTI: $3.00

A progress report is presented for the Physics Division of Lawrence Radiation Laboratory. Topics discussed are elementary particle research, development and operation of bubble chambers, use and programming of computers, nuclear emulsions in space research, S-matrix theory, mesic atoms, field theory, nuclear physics, gravitational studies, and development and operation of accelerators. NSA

N67-19183# Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica.
INTRODUCTION TO RADIATION PHYSICS, CHAPTER IV [INTRODUZIONE ALLA FISICA DELLE RADIAZIONI, CAPITOLO IV]
U. Amaldi, Jr. 28 Jul. 1966 231 p ref In ITALIAN; ENGLISH summary
(ISS-66/27) CFSTI: HC $3.00/MF $0.65

Classical laws of the electromagnetic field are discussed which emphasize the propagation, production, and absorption of energy in free space through electromagnetic waves. Also discussed is the granular structure of matter and the fundamental properties of atoms (dimensions, charge, and mass). The classical distinction between corpuscular and wave radiations is introduced and the classification of known radiations from the point of view of classical physics is given. Author

N67-19190# Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica.
A MONTECARLO COMPUTATION OF MULTIPLE SCATTERING EFFECTS
R. Biancastelli and P. Stern 21 Jul. 1966 29 p refs
(ISS-66/26) CFSTI: HC $3.00/MF $0.65

This report contains the description and the results of a Montecarlo calculation of the multiple scattering effects. The code is written in Fortran IV language. Author

N67-19205 Kyoto Univ. (Japan). Research Institute for Fundamental Physics
POSSIBLE C-NONCONSERVING INTERACTIONS AND MODELS OF ELEMENTARY PARTICLES
Ziro Maki and Isao Umenura Sep. 1966 22 p refs
(RIFP-58) CFSTI: HC $3.00

A systematic survey is made on the possible forms of T-noninvariant interactions of local trilinear type under which hypothetical bosons couple to the bilinear sources of fundamental fields of spin 1/2 (urbaryons) for hadrons. By examining the necessary conditions to be imposed on such an interaction for giving actual effects of C-nonconservation in the hadronic processes, it is shown that the interactions should either contain derivative type of else include the exchange type of sources with appropriate phase differences. The latter type of interactions, which cannot be applied to the single triplet or the L-type quartet models, have, in general, to be reinforced by a symmetry breaking strong interaction that induces the transition between different kinds of urbaryons in each of the models of hadrons. Author

N67-19213# European Organization for Nuclear Research, Geneva (Switzerland).
PROCEEDINGS OF THE 1966 CERN SCHOOL OF PHYSICS, NOORDWIJK-AAN-ZEE, JUN. 6–18, 1966
J. S. Bell 4 Oct. 1955 50 p refs
(CERN 66-29, Vol. 1)

Notes from a series of lectures on weak interactions and current algebras which were presented as part of the CERN School lecture series which was designed to familiarize young post graduate students with the current theoretical and experimental studies in elementary particle physics; are reported. Summarized are notes on the following topics: symmetry, algebra, quark fields and U(3) symmetry, semi-leptonic weak interactions, U(6), saturation and leakage, Adler sum rule, partially conserved axial current (?DDAC), the Adler-Weisberger sum rule, strangeness-changing currents, the current-current interaction, non-leptonic hyperon decays, leptonic decays of kaons, and non-leptonic kaon decay. S.C.W.

N67-19229# Lockheed Missiles and Space Co., Palo Alto, Calif. Research Lab.
CROSS SECTIONS AND RATE CONSTANTS FOR ION-MOLECULE REACTIONS

George Gioumousis Oct. 1966 83 p refs
(Contract Nonr-3368(00))
(LMSC-2-12-66-4; AD-644822) CFSTI: HC $3.00/MF $0.65

The importance of ion-neutral reactions is well recognized, especially in the study of the chemistry of upper atmosphere. The first section of the report is concerned with refining the calculation of the cross section from the long-range interactions, assuming an arbitrary classical potential. The cross section so found is not regarded as an approximation to the reaction cross section, but rather the cross section for any sort of significant interaction, that is, the sum of the cross sections for elastic scattering, inelastic scattering, and the various reactions that can occur. The next section is a rigorous analysis of the experiments, based on the kinetic theory of gases, from the point of view of expressing whatever macroscopic parameters the experiment yields in terms of the reaction cross section, which is assumed known as a function of energy. An approximate method is developed which inverts the relationship and yields the reaction cross section as a function of energy if the experimental data are adequate. The final section applied the above-mentioned method to various reactions. This is believed to be the only way to find the cross section as such for ion-neutral reactions in the energy range somewhat above thermal. Some new and unexpected results were found by this method, especially for the H2, Ne reaction. Author (TAB)

N67-19233# Lockheed Missiles and Space Co., Palo Alto, Calif. Research Lab.
CALCULATION OF THE RATE OF ENERGY LOSS OF SLOW ELECTRONS BY MEANS OF THE EIGENVALUES OF THE BOLTZMANN OPERATOR
George Gioumousis Nov. 1966 19 p refs
(Contract Nonr-3368(00))
(LMSC-2-12-66-5; AD-644825) CFSTI: HC $3.00/MF $0.65

A new method of calculating the slowing-down time of electrons, based on the eigenvalue problem for the Boltzmann collision operator, is developed. The method is formulated for an isotropic electron distribution in a diatomic gas and an initial electron energy below the vibrational threshold. Author (TAB)

N67-19247# Kyoto Univ. (Japan). Research Inst. for Fundamental Physics.
ON APPLICABILITY OF THE RANDOM PHASE APPROXIMATION TO THE COLLECTIVE EXCITATION IN SPHERICAL EVEN NUCLEI. II: CORRECTION TO SO-CALLED "TWO-PHONON" STATES
Masatoshi Yamamura, Akira Tokunaga, and Toshio Marumori Nov. 1966 43 p refs
(RIFP-58) CFSTI: HC $3.00/MF $0.65

This paper checks the concept of the "2-phonon" states through an analysis of the characteristic features of the first order correction to the convential "2-phonon" states under the RPA. Numerical results for Ni-isotopes (Ni^{60} and Ni^{62}) and for the single $j=15/2$ shell model show that the concept of the "2-phonon" states based on the RPA is in break-down, in the sense that the correction is unexpectedly large in the region of the phonon energy of interest. Another important physical situation destroys the concept of the "2-phonon": Coupling of the "2-phonon" modes and 2-quasi-particle excitation mode are essential in most actual nuclei. Author

N67-19257# Kyoto Univ. (Japan). Research Inst. for Fundamental Physics.
ON APPLICABILITY OF THE RANDOM PHASE APPROXIMATION TO THE COLLECTIVE EXCITATION IN SPHERICAL EVEN NUCLEI. I: CORRECTION TO THE FIRST 2^+ STATE
Akira Tokunaga Nov. 1966 49 p refs
(RIFP-57) CFSTI: HC $3.00/MF $0.65

In order to check the applicability of the random phase approximation (RPA), the correction to the RPA for the first 2^+ state in spherical even nuclei is evaluated using a kind of perturbation theory (starting with the solutions of the RPA as zeroth-order approximation). According to the method, insofar as the first-order correction concerns, some ambiguities depending on various methods (presented by several authors) to transcribe the system into the boson space are avoidable. Physical implication of the correction is considered. Numerical results for Ni-isotopes (Ni^{60} and Ni^{62}) and for the single $j=15/2$ shell model show that the correction to the RPA is unexpectedly large in the region of "phonon" energy of interest. Author

N67-19263# Aktiebolaget Atomenergi, Stockholm (Sweden).
ANALYSIS OF THE QUASI-ELASTIC SCATTERING OF NEUTRONS IN HYDROGENOUS LIQUIDS
S. N. Purohit (Rensselaer Polytech. Inst.) Nov. 1966 28 p refs
(AE-259) CFSTI: HC $3.00/MF $0.65

A critical discussion of the quasi-elastic scattering of neutrons by incoherent (hydrogenous) liquids is presented. Using the line shape expression a comparative discussion of several phenomenological models has been carried out. Extension of the Singwi-Sjölander zero phonon expression, for the jump-diffusion model, so as to include the one phonon expression has also been given. For a delayed diffusion model a complete treatment of $S(K,\omega)$ is presented. Along the lines of the macroscopic diffusion cooling, a microscopic diffusion cooling effect in fluids is speculated. Author

N67-19264 Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf (Austria).
ELECTROMAGNETIC SEPARATION OF HIGHLY ENRICHED NOBLE GAS ISOTOPES IN MULTIMILLIGRAM QUANTITIES
[1966] 17 p refs Submitted for Publication
(SGAE-PH-44/1966) CFSTI: $3.00

A method for electromagnetic separation and for collection of multimilligram-quantities of noble gas isotopes is described. A charcoal collector cooled below 100°K was developed which is capable to store the separated noble gas isotopes during the separation. In a test run it was possible to collect 12 mg Xe-131 with an isotopic purity of 99.3%. Author

N67-19270# Oxford Univ. (England). Nuclear Physics Lab.
THE $3/2^- \rightarrow 1/2^-$ MIRROR TRANSITIONS IN MASS 15
H. J. Rose and J. S. Lopes (Port. Nucl. Energy Comm.) Sacavem, Port., Nucl. Energy Comm., 1966 12 p refs
(LFEN.61(β)) CFSTI: HC $3.00/MF $0.65

An error in the calculation of the sign of the E2/M1 mixing ratio of the $3/2^- \rightarrow 1/2^-$, 6.33 Me transition in ^{15}N is corrected. It is shown that a weak coupling treatment cannot yield the required effective charge parameters to describe the mixing ratios of the $3/2^- \rightarrow 1/2^-$ mirror transitions in mass 15. Author

N67-19272* Columbia Univ., New York. Radiation Lab.
PROPERTIES OF SIMPLE ATOMS AND IONS Semiannual Report, 1 Jul.–31 Dec. 1966
R. Novick Feb. 1967 7 p refs
(Grant NsG-360)
(NASA-CR-82462; SAR-8) CFSTI: HC $3.00 CSCL 20H

The following topics were studied: (1) *Optical Excitation with Low Energy Ions*— triplet states in low energy He^+–He collisions; (2) *Electric Field Hanle Effect*—electric field level crossings for measuring differential Stark shift or rubidium; (3) *Fine Structure of Singly Ionized Lithium*—induced magnetic dipole transitions between states of singly ionized lithium at 50 MHz; (4) *Hyperfine*

Structure of the Group II Isotopes—optical double resonance measurements of barium ground states; (5) *Fine and Hyperfine Structure of the 3P State of Lithium*—data evaluation of very low-field level crossings in lithium 7; (6) Direct Detection of the Two-Photon Decay Mode—three photon detector technique for study of two photon spectrum; and (7) *Metastable Autoionizing Atoms*—radio-frequency spectroscopy of Zeeman transition of potassium. G.G.

N67-19322# Oak Ridge National Lab., Tenn.
NUCLEAR AND REACTOR PHYSICS
In its Neutron Phys. Div. Sep. 1966 p 1–13 refs (See N67-19321 08-22) CFSTI: HC $3.00/MF $0.65

Excitation energies for 23 levels of ^{94}Zr between 0.92 and 4.25 MeV are reported. The levels were excited by proton scattering and the analysis used eight pulse-height spectra for laboratory angles between 40 and 80°. The pulse-height spectrum is given for protons scattered at 50°, and recommended values for spin and parity for the 23 levels are tabulated. Simultaneous measurements of the capture and fission cross sections of ^{235}U were analyzed. A figure showing the fission and capture cross sections and their ratio δ_c/δ_f in the energy range 1 to 10 eV, and a table giving the fission and capture resonance integrals over 0.25 lethargy intervals are presented. The neutron spectrum of the Bulk Shielding Reactor was measured from thermal energies to 10^5 eV. A discussion is given of several problems experienced in the operation of the Health Physics Research Reactor, including variations of ±40% in the neutron pulses. Progress is also reported on the construction of an electron linear accelerator to be used as a source of short intense pulses of neutrons. NSA

25 PHYSICS, PLASMA

Includes magnetohydrodynamics. For applications see: 28 Propulsion Systems.

N67-18287# Army Electronics Labs., Fort Monmouth, N. J.
PLASMA PROPERTIES OF KILOAMPERE DISCHARGES
John E. Creedon Nov. 1966 65 p refs
(ECOM-2773; AD-643197) CFSTI: HC $3.00/MF $0.65

Plasma properties and characteristics that are of interest to high-current switching devices were investigated. Peak pulse currents up to 80,000 amperes were used to generate dense plasmas in linear glass-metal diodes. Two tube diameters, 3 and 7.5 inches, were studied. In the case of the 3-inch-diameter diode, the electrode separation was varied from 10.6 to 25.1 cm. Hydrogen gas was studied in the pressure range from 0.5 to 40 torr. Electron densities and temperatures have been determined using spectroscopic techniques. Densities were found to be in the 10 to the 16th power to 10 to the 17th power/cu cm range. Plasma resistivities have been determined from a knowledge of the density and temperature. The observed dependence of resistivity on current and pressure is discussed and the results are compared with resistivities obtained from tube-drop measurements. The effects of impurities and instabilities are also discussed. Author (TAB)

N67-18319*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACE-CHARGE DISTRIBUTION IN A NEUTRAL PLASMA
K. Shimada *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 56–59 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

The spatial distribution of electrons and ions in a plasma was obtained analytically by assuming that the plasma under consideration was electrically neutral. The theory derived from this analysis is compared with experimental results obtained by Bullis using a Langmuir probe. The theoretical characteristic length describing the spatial decay rate of electrons compares favorably with the measured values after probe diffusion limitations are accounted for. Further analysis of the data, in an electron retarding field, indicates that recombination processes dominate the ionization in the plasma. The time rate of the sink of electric charges, which just equals the divergence of particle fluxes necessary to maintain equilibrium, is found to be 5.15×10^3/sec per electron. Author

N67-18363# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Lab. Gas Ionizzati.
BINARY-COLLISION METHOD FOR CALCULATING FOKKER-PLANCK COEFFICIENTS FOR A PLASMA IN A STRONG MAGNETIC FIELD
P. Barberio Corsetti Aug 1966 23 p refs Sponsored in part by EURATOM
(LGI-66/10) CFSTI: HC $3.00/MF $0.65

Fokker–Planck coefficients for a fully ionized gas in a strong magnetic field which is assumed to be constant and uniform are calculated. The Larmor radius of at least one of the two species of particles present (electrons and ions) is assumed to be smaller than the Debye length. The coefficients are calculated by averaging the variations of the particle velocities due to collisions with other particles, over all possible collisions. Such calculations are performed by means of a direct analysis of particle orbits. The results obtained are close to those of Rostoker and Rosenbluth. The coefficients are found to be analogous in form to those for the case of a zero magnetic field, except for a different value of the maximum impact parameter. Besides, collisions between electrons and ions are found to give special contributions. Author (ESRO)

N67-18368# Royal Inst. of Tech., Stockholm (Sweden). Div. of Plasma Physics.
EXPERIMENTAL EVIDENCE OF PLASMA INSTABILITIES
B. Lehnert 11 Oct. 1966 108 p refs Presented at the Gordon Res. Conf. on Plasma Phys., Crystal Mountain, Washington, 8–12 Aug. 1966 Revised
(Rept.-66-14) CFSTI: HC $3.00/MF $0.65

A review is given of the experimental evidence and evaluation of macro- and microinstabilities in a gaseous plasma. The paper briefly describes the physical mechanisms of the instabilities and the experimental methods used in their detection. The present state of research is summarized and discussed in connection with thermonuclear and cosmical problems, with special emphasis on recently obtained results. An extensive list of references on the experimental work in included. Author (ESRO)

N67-18371# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratorio Gas Ionizzati.
CRITERION FOR ADIABATICALLY COMPRESSED LINERS
J. G. Linhart Jul. 1965 14 p refs Sponsored in part by EURATOM
(LGI-65-14) CFSTI: HC $3.00/MF $0.65

The radial implosion of a perfectly conducting cylindrical liner on a tube of magnetic flux may generate diverging shock-waves in a liner-medium. In order to get some feeling for the criteria governing the appearance of such shocks, an approximate treatment using a family of characteristics is developed in this report. Author (ESRO)

N67-18374# Royal Inst. of Tech., Stockholm (Sweden). Div. of Plasma Physics.
LIMITATIONS OF THE STEADY STATE IN A CURRENT CARRYING PLASMA
Per Carlqvist Dec. 1966 17 p refs
(Rept.-66-10) CFSTI: HC $3.00/MF $0.65

A gravitational field acts upon a non-magnetized and fully ionized plasma which carries ion and electron currents. Of most

interest are those conditions which determine whether a stationary state exists for the plasma or not. When the current densities assume values between certain limits, the density distribution of the charged particles cannot be both stationary and continuous. A local heating of the plasma or a constriction of the tube containing the plasma causes the same effect as the gravitational field. This effect is compared to the two-stream instability and to the phenomenon of run-away. Author (ESRO)

N67-18433* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

KINETIC EQUATION FOR AN UNSTABLE PLASMA

John C. Price [1963] 10 p refs Submitted for publication
(NASA-TM-X-57293) CFSTI: $3.00 CSCL 20I

The kinetic equation of Lenard and Balescu for a uniform plasma is restricted in validity for it contains integrals which diverge when the plasma is unstable, i.e. when some perturbations on the system may tend to grow expotentially in time. A more general equation is presented which is valid for both stable and unstable plasmas. The kinetic equation is non-Markoffian in that it depends explicitly on the initial value of the pair correlation function, and contains a time integral over the past behavior of the system. The kinetic equation leads to the usual H theorem and it satisfies the conservation laws. R.N.A.

N67-18444*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE FIRST CORRECTION TO THE SECOND ADIABATIC INVARIANT OF CHARGED-PARTICLE MOTION

T. G. Northrop, C. S. Liu (Calif. Univ., Berkeley), and M. D. Kruskal (Princeton Univ.) 6 Jan. 1966 44 p refs Submitted for publication
(Contract W-7405-ENG-48; AT(30-1)-1238)
(NASA-TM-X-57224; UCRL-18610) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The second term has been obtained in the asymptotic series for the second (longitudinal) adiabatic invariant of charged particle motion in a static magnetic field. This correction to the lowest order invariant has two sources: the correction to the lowest order magnetic moment and the integrated effect of the guiding-center drift across the field lines. The second term is found to vanish at the mirror points; therefore during its motion between mirror reflections, the guiding center deviates from the surface on which the lowest order invariant is constant and intersects this surface at reflection. Author

N67-18463# Stanford Univ., Calif. Inst. for Plasma Research.

ELECTRON BEAM PROBING STUDIES OF BEAM/PLASMA INTERACTIONS

A. B. Cannara and F. W. Crawford Aug. 1966 34 p refs
(Contract AT(04-3)-326)
(SU-IPR-90) CFSTI: HC $3.00/MF $0.65

Experimental observations are described of electron beam/plasma amplification in a low pressure, beam produced, mercury vapor discharge. A nonperturbing probing technique, employing a fine auxiliary electron beam, was used to measure rf growth, phase velocity, and axial and radial electric field profiles in the interaction region. The comprehensive data obtained were compared with predictions based on cold and warm plasma theories of beam/plasma amplification. It is concluded that the experimental growth rates and electric field profiles are approached more closely by warm plasma theory, but that the measured phase velocities are somewhat slower than either theory suggests. The electric field profiles are smoother than expected, probably owing to the beam boundary being less sharp in practice then is assumed in the theories. Author (NSA)

N67-18609# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Plasmaphysik.

ADIABATIC INVARIANCE IN THE MIDDLE OF SPATIAL FIELD REVERSAL [ADIABATISCHE INVARIANZ IN MITTEL BEI RAEUMLICHER FELDUMKEHR]

Lutz Janicke Jul. 1966 48 p In GERMAN; ENGLISH summary
(JUL-384-PP)

The adiabatic invariance properties of charged particles in transient weakly but spatial strongly changing electromagnetic fields were investigated. Such fields which lead to the problem of the one-dimensional oscillator whose potential shows two minima were considered specially. This potential form occurs in fields with spatial field reversal, for instance in the β pinch with antiparallel interior magnetic fields. For particles with energy values in the vicinity of the intermediate maximum, the adiabatic invariance of the effective integral $J = \oint p dq$, detectable above and below in the regions, is no longer valid. J is no longer a constant function of the energy. These difficulties can be eliminated by a modification of the definition which permits the invariants to be unaltered in the usual areas. For the modified magnitude K, it can be shown by utilization of the conservation of area in the phase plane, that a random particle group in the phase plane of the one-dimensional oscillator K, in the mean, is adiabatically invariant in the system $\epsilon\, 1n^4\epsilon$. Author (NSA)

N67-18627 Atomic Energy Commission, Oak Ridge, Tenn. Div. of Technical Information Extension.

NUCLEAR FUSION—TRANSLATED SELECTED ARTICLES

1966 70 p refs Transl. into ENGLISH from Nucl. Fusion (Vienna), v. 5, no. 2, 1965 p 125–143; 150–155
(AEC-TR-6670) CFSTI: HC $3.00

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N67-18628 Atomic Energy Commission, Oak Ridge, Tenn. Div. of Technical Information Extension.

DRIFT CYCLOTRON INSTABILITY OF PLASMA WITH HOT IONS

A. B. Mikhailovskii *In its* Nucl. Fusion 1966 p 1–50 refs (See N67-18627 08-25) CFSTI: HC $3.00

The role of drift cyclotron instability in a spatially inhomogeneous plasma is analyzed. The instability can occur in a not-too-dilute plasma with a finite Larmor radius of the ions $(Q/a)^2 > (C_A/C)^2$ (C_A is the Alfvén velocity, Q is the Larmor radius of the ions, and a is the characteristic dimension of the inhomogeneity). A detailed investigation was made of the effects on the instability criterion of various factors: the curvature of the lines of force and the inhomogeneity of the magnetic field, the form of the equilibrium particle velocity distribution function, the relationship between the transverse and longitudinal dimensions of the system, and the ratio of electron to ion temperature. It is concluded that, if the flute (hydrodynamic) instability is stabilized, the drift cyclotron instability is the most dangerous for a system with a finite Larmor radius of the ions. The instability may be overcome by creating a system with finite intersection of the magnetic lines of force (shear). In short systems the instability need not occur if there is cold plasma of finite density between the hot plasma and the conducting ends of the apparatus. Author (NSA)

N67-18629 Atomic Energy Commission, Oak Ridge, Tenn. Div. of Technical Information Extension.
CONFINING A PLASMA IN A TOROIDAL MAGNETIC FIELD WITH A CONDUCTIVE DIAPHRAGM
V. D. Shafranov *In its* Nucl. Fusion 1966 p 51–56 refs (See N67-18627 08-25) CFSTI: HC $3.00/MF $0.65

A plasma column is considered that is maintained in equilibrium in a toroidal magnetic field and its shape defined by a diaphragm. The maximally admissible value of $\beta = 8\pi p/B^2$ for such a retention is $\beta_{max} = 4b/\pi^2 R$ in which b is the small radius and R the large radius of the toroidal chamber containing the plasma. Author (NSA)

N67-18630 Atomic Energy Commission, Oak Ridge, Tenn. Div. of Technical Information Extension.
FLUTE INSTABILITY IN A RAREFIED INHOMOGENEOUS PLASMA IN THE PRESENCE OF A NONUNIFORM ELECTRIC FIELD
V. V. Arsenin *In its* Nucl. Fusion 1966 p 57–64 refs (See N67-18627 08-25) CFSTI: $3.00

Flute perturbations of a strongly inhomogeneous dilute plasma in an inhomogeneous electric field are discussed. An inhomogeneous electric field, appearing at weak charge separation in a region with a width the order of an ion Larmor radius in which plasma is inhomogeneous, does not affect the stability of long-wave oscillations of low frequency. The case of a very strong inhomogeneity is also examined in which the characteristic dimension at which the electric field changes is the order of an electron Debye length. In this case perturbations with a wavelength the order of an inhomogeneity dimension can be unstable. Author (NSA)

N67-18674 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneaux.
ACCELERATION OF PLASMAS BY PROGRESSIVE WAVES [ACCELERATION DE PLASMAS PAR ONDES PROGRESSIVES]
Th. Moulin, J. Paulon, R. Peyret, and J. P. Rager *In its* Sci. Sessions of the O.N.E.R.A. [1965] p 23 (See N67-18661 08-34) CFSTI: $3.00

For application to aerospace propulsion, summarized technical details are reported on the plasma acceleration for cases of weakly ionized gas, and for completely ionized gas. Assuming that an ionized fluid is in weak equilibrium, magnetohydrodynamic equations may be derived and the plasma mass as a function of time evolved therefrom. Theoretical data are included on the thermodynamic behavior of a less dense, completely ionized gas; this theory was verified with the aid of a progressive wave, argon gas accelerator. Transl. by R.Ll.

N67-18712*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
EFFECT OF COULOMB COLLISIONS ON CONTRASTREAMING PLASMAS
B. Buti and S. K. Trehan [1965] 44 p refs Submitted for Publication
(NASA-TM-X-57288) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The instability of contrastreaming plasmas is investigated accounting for the Coulomb collisions via the Fokker–Planck coefficients in the Boltzmann equation. The dispersion relation, obtained on the assumption that the Coulomb collisions are weak, is solved on the additional assumption that the phase velocity of the wave is much larger than the mean thermal velocity of the particles. It is found that while the temperature has the effect of increasing the maximum wavenumber below which the plasma is unstable, and the collisions have no effect on this wavenumber. The growth rate of maximum instability decreases, compared to its value for a cold plasma, with thermal motions and increases when the collisions are taken into account. Author

N67-18714*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE CAPILLARY INSTABILITY OF A JET CARRYING AN AXIAL CURRENT
N. K. Nayyar and S. K. Trehan [1965] 23 p Submitted for Publication
(NASA-TM-X-57047) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The capillary instability of a liquid jet carrying an axial volume current is investigated for a varicose deformations (m=0). It is found that the inclusion of Hall current in Ohm's law leads to overstability of the jet, albeit with small frequency of oscillation. Author

N67-18722# New York Univ., N. Y. Magneto-Fluid Dynamics Div.
STEADY NONLINEAR WAVES IN A WARM COLLISION-FREE PLASMA
H. Kaver and G. K. Morikawa 1 Apr. 1966 40 p refs
(Contract AT(30-1)-1480)
(NYO-1480-54; MF-50; TID-4500) CFSTI: HC $3.00/MF $0.65

The speed and structure of steady nonlinear waves moving with uniform velocity in an oblique direction across a magnetic field in a collision-free plasma with temperature are described. This is a self-consistent formulation in which the plasma motion is governed by the Vlasov equations for ions and electrons coupled to the Poisson–Maxwell equations. This difficult problem can be solved in the limiting case of small-amplitude nonlinear waves if we assume that the same scaling laws hold for the warm plasma as those for a cold plasma. Author

N67-18882# Argonne National Lab., Ill. Reactor Engineering Div.
CHANNEL-WALL LIMITATIONS IN THE MHD INDUCTION GENERATOR
William D. Jackson (MIT) and Edward S. Pierson Mar. 1966 55 p refs
(Contract W-31-109-ENG-38)
(ANL-7148) CFSTI: HC $3.00/MF $0.65

Materials problems influencing the design and performance of the MHD induction generator are discussed. The previous analysis of the machine is reviewed and extended to include electrically-conducting channel walls and thermal insulation. The infinite-length machine is examined in detail, including both an approximate analysis to show the general behavior, and an exact solution to provide numerical data. The power flow between the field structure and the fluid is used to determine the effect of the conducting wall with practical material properties and machine dimensions. It is shown that the wall thickness has to be very small for acceptable generator performance, and that this requirement raises severe structural problems. The effect of the insulation is determined to be small. By means of an approximate solution, the previous analysis of the finite-length machine is also extended to include walls and insulation. Author (NSA)

N67-18885# Princeton Univ., N. J. Plasma Physics Lab.
NUMERICAL EXPERIMENTS IN PLASMA PHYSICS
Ramy A. Shanny, J. M. Dawson, and J. M. Greene Jul. 1966 84 p refs
(Contract AT(30-1)-1238)
(MATT-441) CFSTI: HC $3.00/MF $0.65

A model of a plasma is constructed for numerical computations. The plasma represented by the model consists of electrons subjected to a one-dimensional self-consistent electric field, and to collisions with ions, which are infinitely heavy and uniformly distributed throughout the plasma. The model computes the exact motion of the electrons due to the electric field, and a Monte–Carlo technique is used to account for corrections in the trajectories due to encounters with ions. The model to its lower order is identical to

the Fokker–Planck equation with a Lorentz gas collision term. Mathematical difficulty in the solution of the Fokker–Planck equation appears when studying inherently nonlinear effects, and when the effect of collisions is not negligible. Numerical solutions for several such problems were obtained using the model. The effect of collisions on Landau damping and on the growth of an instability caused by a hump in the tail of the velocity distribution was studied. The validity of the collision simulation of the model was checked by measuring the dc conductivity, and comparing the result with the Spitzer–Härm conductivity. Author (NSA)

N67-18990*# Massachusetts Inst. of Tech., Cambridge. Center for Space Research.
CONTINUUM ELECTROMECHANICS GROUP ELECTROMECHANICAL CO-STREAMING AND COUNTER-STREAMING INSTABILITIES
Frederick D. Ketterer Aug. 1966 55 p refs
(Grant NsG-368)
(NASA-CR-82482; CSR-TR-66-15) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The dynamics of two highly conducting, finite length streams in relative motion, coupled by a transverse electric or longitudinal magnetic field are examined in detail. The systems may be mathematically described by two second order coupled hyperbolic partial differential equations. Four classes of flow exist: (1) subcapillary (2) supercapillary co-streaming (3) supercapillary counter-streaming and (4) subcapillary-supercapillary flow. The first three are considered in the present paper. The behavior of the infinitely long system is examined from the dispersion relation and the Bers–Briggs stability criterion. The eigenvalue problem is formulated for class (1) and (3) flows (no eigenvalues exist for class (2) flow) and the complex eigenfrequencies computed. Electrohydrodynamic experiments on these systems are described compared with the theory. Physical explanations are given for the observed instabilities. Author

N67-19040*# California Univ., Berkeley. Dept. of Physics.
THE EVOLUTION OF WAVE CORRELATIONS IN UNIFORMLY TURBULENT, WEAKLY NONLINEAR SYSTEMS
Ronald C. Davidson Jan. 1967 32 p refs
(Grant NGR-05-003-220)
(NASA-CR-82471) CFSTI: HC $3.00/MF $0.65 CSCL 20I

A formalism is developed describing the time evolution of wave correlations. The statistics are built into the formalism a priori. With closure of the hierarchy of equations for wave correlations appropriate to the inclusion of resonant three-wave interactions, a nonlinear kinetic equation for the two-wave correlations is derived and various properties of this equation are discussed. The effects of both bilinear and trilinear nonlinearities are considered. Modifications of the formalism in situations where there is a weak linear instability are also considered. Author

N67-19043*# Michigan Univ., Ann Arbor. Electron Physics Lab.
EFFECT OF ELECTROSTATIC FIELDS ON THE PROPAGATION OF ELECTROMAGNETIC WAVES IN A FINITE TEMPERATURE MAGNETOACTIVE PLASMA
H. C. Hsieh Oct. 1966 72 p refs
(Grant NsG-696; Proj. 06621)
(NASA-CR-82372; TR-96) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The dispersion relations for a finite temperature two-component plasma subjected to crossed electrostatic and magnetostatic fields have been derived using the coupled Boltzmann–Vlasov–Maxwell equations under the one-dimensional, small-signal assumptions. The derived dispersion relation is given in a form in which various characteristic modes of the system can be readily identified. Moreover it is given in a form particularly suitable for a study of the coupling between the transverse circularly polarized wave and the longitudinal wave. Inspection of the derived dispersion relation reveals that the coupling of the longitudinal mode to the transverse mode may take place in the presence of a transverse electrostatic field. Author

N67-19050*# California Univ., Berkeley. Dept. of Physics.
ON THE USE OF A PRIORI STATISTICS IN PROBLEMS OF PLASMA TURBULENCE
Ronald C. Davidson [1966] 20 p refs
(Contracts NGR-05-003-220; AT(30-1)-1238)
(NASA-CR-82524) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The usual procedure in problems of uniform plasma turbulence is to perform an *a posteriori* statistical averaging (the random phase approximation) on perturbation solutions to the Vlasov equation. A more direct formulation in which ensemble averaging is done *a priori* is advocated in this article. Using the Vlasov equation as the dynamical equation for an individual system, equations are constructed for the time evolution of correlations in a spatially homogeneous ensemble of such plasmas. This hierarchy, which is identical to the BBGKY hierarchy without the effects of single particle encounters, automatically embodies the random phase approximation. Upon ordering the system of equations in the weak turbulence parameter E^2/nmv_{av}^2, the questions of closure and time validity are examined. Author

N67-19072# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Stuttgart (West Germany). Institut fuer Energiewandlung und Elektrische Antriebe.
EXPERIMENTAL INVESTIGATIONS ON AN ELECTRODELESS PLASMA PROPULSION SYSTEM WITH A CONICAL DISCHARGE COIL [EXPERIMENTELLE UNTERSUCHUNGEN AN EINEM ELEKTRODENLOSEN PLASMABESCHLEUNIGUNGSSYSTEM MIT KONISCHER ENTLADUNGSSPULE]
Manfred M. Savary Nov. 1966 41 p refs In GERMAN; ENGLISH summary
(DVL-579; DLR-FB-66-73) CFSTI: HC $3.00/MF $0.65

Distribution of plasma velocity in the direction of propagation was measured on an electrodeless magnetohydrodynamic propulsion system with a conical discharge coil. Photomultipliers both in a gas-filled tube and in pulsed-gas mode were used, and time-resolved displays of plasma pulses were obtained. Plasma motion and distribution were calculated in a first approximation numerical solution by successively analyzing a single photomultiplier display, for which a modified photomultiplier circuit arrangement was developed and calibrated. Author

N67-19164# Deutsche Verschsanstalt fur Luft- und Raumfahrt, Aachen (West Germany). Institut fuer Theoretische Gasdynamik.
MAGNETOGASDYNAMIC FLOWS WITH ALIGNED FIELD INCLUDING SHOCK WAVES [MAGNETOGASDYNAMISCHE STROEMUNGEN MIT STOSSWELLEN BEI EINEM ZUR ANSTROEMUNG PARALLELEN MAGNETFELD]
Ingolf Teipel Oct. 1966 34 p refs In GERMAN; ENGLISH summary
(DVL-567; DLR-FB-66-66) CFSTI: HC $3.00/MF $0.65

In order to calculate the hyperbolic flow field past slender profiles, a method is applied by which all dependent and independent variables are developed in characteristic coordinates. The influence of a magnetic field aligned to the free stream is studied. This method also permits inclusion of weak shock waves. Particularly the phenomenon of forward-running waves is discussed. Author

N67-19180# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Stuttgart (West Germany). Institut fuer Plasmadynamik.
CALCULATIONS OF TRANSPORT COEFFICIENTS OF THERMIC NITROGEN AND ARGON PLASMAS [BERECHNUNGEN DER TRANSPORTKOEFFIZIENTEN VON THERMISCHEN STICKSTOFF- UND ARGONPLASMEN]
Joachim Artmann and Willy L. Bohn Oct. 1966 35 p 1966 35 p refs In GERMAN; ENGLISH summary
(DVL-569; DLR-FB-66-68) CFSTI: HC$3.00/MF$0.65

The knowledge of the transport coefficients is of importance for numerous problems in plasmadynamics. In this report heat conductivity, electrical conductivity and viscosity are calculated for plasmas of nitrogen and argon up to 100,000°K. Attention is given to the contribution of all ionization reactions; they could be taken into account by a special numerical method. In order to check the results with experimental data, the atom-ion cross section was multiplied by 10^{-2}. The effect of an external magnetic field on the transport coefficients is shown. Author

N67-19212# United Kingdom Atomic Energy Authority, Culham (England). Research Group.
FAST HIGH VOLTAGE Z-PREIONIZATION OF A MEGAJOULE THETA PINCH
A. A. Newton Jul. 1966 13 p refs
(CLM-R-62) HMSO: 2s 6d

The impurities in theta pinch plasmas are found to originate from the interaction of the pre-ionized plasma with the tube wall when the theta pinch bank is switched on. An improved pre-ionizer is described which reduces the concentration of oxygen in the final plasma by minimizing the wall contact in the early stages. The conditions necessary for increased purity result in less efficient magnetic compression of the plasma. Various Z-preionization schemes are compared by observing their effect on the diamagnetism of the final plasma. Author

26 PHYSICS, SOLID-STATE

Includes semiconductor theory; and superconductivity. For applications see: 16 Masers. For related information see also: 10 Electronics.

N67-18318*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
THE ELECTRO-OPTIC EFFECT IN BARIUM TITANATE
A. R. Johnston *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 52–58 refs (See N67-18301 08-34) CFSTI: HC$3.00/MF$0.65

A study was made of the dispersion of the electro-optic effect in single crystal $BaTiO_3$. The results, obtained by previously described methods, show the dependence of the electro-optic effect on wavelength. This data is of interest in obtaining a description of the nonlinear interaction which produces the electro-optic effect. To date, data have been obtained only for the unclamped effect. Both r_{42} and r_c were measured at room temperature between 400 Å and 1.1 microns. R.N.A.

N67-18320*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
LIMITATIONS IMPOSED BY DEMAGNETIZING FIELDS ON BIT PACKING DENSITIES WITHIN Mn–Bi FILMS
G. Lewicki and D. I. Tchernev *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 59–62 refs (See N67-18301 08-34) CFSTI: HC$3.00/MF$0.65

Limitations imposed by demagnetizing fields on the maximum density of Curie point writing on thin ferromagnetic films of manganese bismuthide are discussed. These thin films are potential media for high density information storage. Bits in the form of ones or zeros correspond to areas of the film magnetized in one of two possible directions normal to the plane of the film. The magnetization state of these areas is determined optically with the use of the Faraday effect. Curie point writing refers to a method of reversing the magnetization direction within a selected region of the film. The maximum value of the demagnetizing field was calculated for an arrangement where bits correspond to circular areas on a continuous film, and one where bits correspond to circular areas on a discontinuous film. These calculations, which allow the determination of the maximum packing densities achievable on thin manganese bismuthide films under the condition that there is a maximum practically realizable field for overcoming demagnetizing fields, are presented. R.N.A.

N67-18322*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
THERMOELECTRIC POWER AND THE FERMI SURFACE IN SILVER–GOLD ALLOYS
I. Weinberg *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 64–66 refs (See N67-18301 08-34) CFSTI: HC$3.00/MF$0.65

A program was initiated to study the thermoelectric power in alloys of the noble metals to determine and extend the limitations of the thermoelectric power as a Fermi surface probe for ultimate use in the transition metal alloys. The initial work was directed at alloys of silver and gold because they form solid solutions in all proportions with negligible variation in lattice constant from pure silver to pure gold. In addition, they are monovalent, have the same crystal structure, have nearly the same atomic radii, and have the same Fermi energies. Data are shown which confirm that negligible changes can be expected in the Fermi surface with alloying for dilute alloys of gold and silver. R.N.A.

N67-18414*# Hughes Aircraft Co., Newport Beach, Calif.
EFFECT OF RADIATION ON THE STABILITY OF SILICON NITRIDE AND METAL NITRIDE SEMICONDUCTOR FET DEVICES Quarterly Report, 1 Jul.–1 Oct. 1966
R. P. Totah 1 Oct. 1966 42 p refs
(Contract NAS8-18003)
(NASA-CR-82020; QR-1) CFSTI: HC $3.00/MF $0.65 CSCL 09A

This report is divided into three main work areas: (1) The preparation of the silicon nitride films and the evaluation of those films as a capacitor dielectric. (2) Etch rate enhancement of the Si_3N_4 films due to irradiation. (3) Radiation test equipment set-up, and evaluation of the test procedure. Author

N67-18469# Minnesota Univ., Minneapolis. School of Physics.
EXPERIMENTAL AND THEORETICAL STUDIES IN SOLID STATE AND LOW TEMPERATURE PHYSICS Annual Progress Report, 1966
A. M. Goldman, L. H. Nosanow, W. Zimmermann, and W. Weyhmann Sep. 1966 29 p refs
(Contract AT(11-1)-1569)
(COO-1569-1) CFSTI: HC$3.00/MF$0.65

Various experimental and theoretical investigations in superconductivity, theory of quantum crystals, mixtures of helium isotopes, magnetism in metals, superfluidity in liquid helium, and millidegree refrigeration facility are described. NSA

N67-18497# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
UKRAINIAN JOURNAL OF PHYSICS, VOLUME 10, NO. 6 Selected Articles
7 Dec. 1966 22 p refs Transl. into ENGLISH from Ukr. Fiz. Zh. (Kiev), v. 10, no. 6, 1965 p 630–635; p 676–681
(FTD-HT-66-218; TT-67-60207; AD-643638) CFSTI: HC $3.00/MF$0.65

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2. DERIVATION AND PROPERTIES OF FIBROUS MAGNESIUM OXIDE CRYSTALS S. G. Tresvyatskiy, N. D. Nazarenko et al p 8–15 refs (See N67-18499 08-26)

N67-18498# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

GALVANOMAGNETIC PROPERTIES OF MERCURY TELLURIDE MONOCRYSTALS

L. K. Chubova, M. P. Gavaleshko, and V. V. Yeremenko *In its* Ukrain. J. of Phys., v. 10, no. 6 (Selected Articles) 7 Dec. 1966 p 1–7 refs (See N67-18497 08-26) CFSTI: HC $3.00/MF $0.65

Hall coefficients and transverse magnetoresistance are measured at various temperatures for n- and p-types of pure mercury telluride single crystals grown by zone crystallization. The purest samples were the n-type with a carrier density of $\approx 5\times10^{17}$ cm^{-3} and a mobility of $\approx 2\times10^{4}$ cm^2/v-sec at room temperature. In samples containing impurities, mobility of the carriers does not exceed 10^2 to 10^3 cm^2/v-sec, whereas carrier density is about 10^{19} cm at 20.4°K. In pure n-type samples, electron mobility varies monotonically with temperature, with a maximum occurring between room and liquid nitrogen temperatures. The detected anisotropy of the transverse magnetoresistive effect depends substantially on temperature; and experimental data indicate that a simple one-zone model is inadequate for such determinations. M.W.R.

N67-18499# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

DERIVATION AND PROPERTIES OF FIBROUS MAGNESIUM OXIDE CRYSTALS

S. G. Tresvyatskiy, N. D. Nazarenko et al *In its* Ukrain. J. of Phys., v. 10, no. 6 (Selected Articles) 7 Dec. 1966 p 8–15 refs (See N67-18497 08-26) CFSTI: HC $3.00/MF $0.65

A vacuum furnace with graphite heater was used to grow fibrous crystals of magnesium oxide with a length of more than 10 mm. A condensation method was used with MgO vapor to form these transparent fibers with diameters of 1.5 to 20 μm, with a refraction index of 1.73 ± 0.01. Testing for rupture and elongation indicated that crystals with a fiber diameter of less than 5 μm usually have a strength of $10^4 kg/cm^2$, which is approximately one-tenth the theoretical strength value for magnesium oxide monocrystals. M.W.R.

N67-18555# Stanford Research Inst., Menlo Park, Calif.

DETERMINATION OF THE OPTICAL PROPERTIES OF NEODYMIUM-DOPED GLASSES Final Report

Gilbert R. Haugen Jun. 1966 108 p refs

(Contract DA-04-200-AMC-995(Z))

(AD-640160) CFSTI: HC $3.00/MF $0.65

The absorption bands, emission bands and their bandwidths, excitation bands, quantum efficiencies, and lifetimes of the metastable states of ten neodymium-doped glasses were determined at 25° and −196°C. It was found that: the absorption and emission spectra are independent of the glass; the emission bandwidth depends on the glass host and the temperature; the spectral shape changes slightly with temperature; the quantum efficiencies and lifetimes depend on the glass composition and are essentially independent of temperature. The maximization of optical pumping efficiency was discussed in terms of the quantum efficiency variation with excitation wavelengths, and the relative lasing efficiency at a given rate of population of the excited states was determined as a function of the glass composition. Extensive graphs are included. A description is given of the spectrofluorophosphorimeter, an instrument which allows the determination of fluorescence and phosphorescence spectra, fluorescence and phosphorescence excitation spectra, and the decay of triplet states involved in phosphorescence. N.E.N.

N67-18642# Brookhaven National Lab., Upton, N. Y.

THE EFFECTS OF ULTRAVIOLET LIGHT ILLUMINATION ON THE THERMOLUMINESCENCE OF CALCITE

P. J. Kemmey (Picatinny Arsenal), J. E. Vaz (Kans. Univ., Lawrence), and P. W. Levy [1965] 27 p refs Presented at the Conf. on Appl. of Thermoluminescence to Geol. Probl., Spoleto, Italy, 3–16 Sep. 1966; Sponsored by NATO and AF Prepared with Kans. Univ.

(Contract AT(30-2)-GEN-16)

(BNL-10561; CONF-660919-2) CFSTI: HC $3.00/MF $0.65

Measurements of thermoluminescence spectra were made on samples of uv irradiated Joplin calcite. The purpose was to determine the mechanism of charge redistribution between the defect centers responsible for the observed thermoluminescence. Illumination with ultraviolet light is shown to produce changes in the intensity of all glow peaks. Glow peaks which are thermally removed before illumination show increases in intensity upon illumination while peaks which are present before illumination are reduced in intensity. The rate at which changes are produced in the glow peaks depends on the temperature of the sample and wavelength of the light. Wavelengths in the region of 2900 and 2500 Å are particularly effective in producing changes in peak intensities. The effects of illumination are more pronounced in gamma irradiated samples than in natural samples. The above effects may be accounted for in terms of a defect model which assumes the presence of three sets of charge traps and a recombination center in addition to the luminescent center. Author (NSA)

N67-18689*# National Bureau of Standards, Boulder, Colo.

RESEARCH AND DEVELOPMENT OF SUPERCONDUCTING THIN FILMS Final Report, 15 Dec. 1965–15 Dec. 1966

R. S. Collier, R. A. Kamper, L. O. Mullen, and R. J. Duff 31 Dec. 1966 13 p refs

(NASA Order C-75305-A; NBS Proj. 31503-12-3150436)

(NASA-CR-72174; NBS-9269) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The effort on superconducting thin films was primarily concerned with the production of good quality niobium films. Deposition parameters were varied, resulting in different values for the critical temperatures. The highest value was 8.8° K (as compared with 9.0° K for the high purity starting material). We have made preliminary tunneling measurements on Pb films in a magnetic field; for magnetic field and critical temperature measurements, a cryostat was built which is stable (in a changing magnetic field) to .001° K in the range 5–10° K. We have also done some high vacuum annealing of large niobium single crystals. The following deliveries were made to the contractor: (1) one sample of vacuum annealed niobium crystal, (2) several lead films, and (3) high purity niobium films. Author

N67-18988*# Hiram Coll., Ohio. X Ray Physics Lab.

DEFECT PRODUCTION IN SINGLE CRYSTALS RESULTING FROM ION BOMBARDMENT Semiannual Status Report, 1 Jun.–31 Dec. 1966

Lawrence B. Shaffer 13 Jan. 1967 15 p refs

(Grant NGR-36-019-001)

(NASA-CR-82470; SASR-1) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Progress is reported in a study of the damage produced on the surface of metal single crystals during ion bombardment. The technique being developed will be useful in investigating single crystals using low energy electron diffraction methods, as well as other areas where information as to the dislocation density and

interstitial content of a surface under ultrahigh vacuum is useful. Consideration was given to the design of the experiment and to controlling the parameters, with emphasis on the sensitivity of the X-ray method of detecting small changes in the surface condition and on the vacuum environment around the crystal. C.T.C.

N67-19008# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
ELECTRICAL CONDUCTIVITY OF UO_2. PART 1: SINGLE CRYSTALS
J. L. Bates, C. A. Hinman, and T. Kawada Aug. 1966 29 p refs
(Contract AT(45-1)-1830)
(BNWL-296, Pt. 1) CFSTI: HC $3.00/MF $0.65

The electrical conductivity of near-stoichiometric single-crystal $UO_2(UO_{2.001})$ was measured at room temperature to 3000°K. Below ≈550°K, the curve of the log σ versus T^{-1} is linear having calculated activations energies at 0.17 to 0.20 eV. At 550 to 1250°K, a change in slope occurs which appears as a hump in the curve. With increasing temperature, the electrical conductivity increases rapidly above ≈1250°K where the conduction changes from p-type to n-type. The activation energy increases with temperature from ≈1.1 to ≈1.6 eV with the best linear fit of ≈1.5 eV. The high temperature conduction is assumed to be intrinsic; however a large difference exists between the thermal energy gap (3.0 eV) and that derived from optical absorption data (5.25 eV. Author

N67-19118* National Bureau of Standards, Washington, D. C.
SUPERCONDUCTIVE PROPERTIES OF CERAMIC MIXED TITANATES
J. F. Schooley, H. P. R. Frederikse, W. R. Hosler, and E. R. Pfeiffer [1966] 22 p refs
(NASA Order R-09-022-033)
(NASA-CR-82657) CFSTI: $3.00 CSCL 20L

The superconducting transition temperature of a series of mixed barium-strontium and calcium-strontium titanate ceramic specimens have been determined. For several of these samples the low-field magnetization has also been investigated. The results are compared with those obtained from single-crystal $SrTiO_3$. Author

N67-19140*# Delaware Univ., Newark. Dept. of Physics.
ELECTRICAL CONTACTS TO CADMIUM SULFIDE SINGLE CRYSTALS Technical Report No. 2
Robert Burton Hall (M.S. Thesis) Jun. 1966 70 p refs
(Grant NsG-573)
(NASA-CR-82441) CFSTI: HC $3.00/MF $0.65 CSCL 20L

It is well known that at room temperature ohmic-behaving electrical contacts to CdS single crystals can easily be attained. However, at temperatures greater than 100°C such contacts exhibit instability (e.g., diffusion of indium into the bulk of the crystal behavior). A multilayer technique has been developed which permits evaporated electrodes to perform ohmically up to 300°C. This technique is characterized by the usage of a preparative metal to "clean" the surface of the crystal to be electroded, an active metal to serve as the ohmic-behaving electrical contact, and a covering metal to carry current and act as a diffusion sink. Although in half the cases a heat treatment of the multilayer-crystal system is necessary to create an ohmic-behaving contact, the results using titanium as the preparative metal and aluminum as the active metal have been completely successful. Author

N67-19165 Lockheed Missiles and Space Co., Palo Alto, Calif.
ENERGY LEVEL DIAGRAM OF TITANIUM OXIDE
G. Perny and R. Lorang [1966] 8 p refs Transl. into ENGLISH from J. Chim. Phys. (Paris), v. 63, 1966 p 833–837

Data furnished by absorption spectroscopy and the investigation of the photochemical behavior of some of the observed bands permit the authors to propose a new energy-level diagram for titanium oxide. The forbidden bandwidth would be about 18 eV; it would be composed of acceptor and donor levels provided by the twice-ionized oxygen holes and interstitial Ti^{+3}ions. The different absorption bands of the spectrum correspond to the excited states of these levels. The triplet bands located in the near infrared are described on the basis of an $(e/e/O_V^{++})^0$ type orthohelium model. They belong to superficial lattice defects. Author

N67-19167# Lockheed Missiles and Space Co., Palo Alto, Calif.
DEFECTS IN THE TiO_2 LATTICE
G. Perny and R. Lorang [1966] 7 p refs Transl. into ENGLISH from J. Chim. Phys. (Paris), v. 63, 1966 p 823–826

It is shown in this paper that the origin and nature of lattice defects in TiO_2 are still quite controversial. Recent research permits submission of a fundamental hypothesis, however: that of the primary influence of Ti^{+3} ions in the lattice on the semiconducting and other properties. They will be given precise localization in another article on the basis of new data provided by absorption spectroscopy. Author

N67-19221# New York Univ., N. Y. Radiation and Solid State Lab.
MECHANISMS OF ENERGY TRANSFER IN DIELECTRICS Final Report, 1 Nov. 1964–31 Jan. 1966
Hartmut P. Kallmann Ft. Monmouth, N. J., Army Electron. Command, Jan. 1967 95 p refs
(Contract DA-28-043-AMC-00129(E))
(ECOM-00129-F; AD-644621) CFSTI: HC $3.00/MF $0.65

The effect of X-rays on the electric behavior of organic materials was studied. A new method to determine charge production was used. It allows to measure the charge production after the exciting radiation and the external field were turned off; it allows further to determine the effects of X-rays when only an internal field is present. Anthracene and polystyrene have been investigated so far. Contrary to the effect of excitation by light which produces charges at the interfaces of organic materials, X-rays produce charges only in the bulk. The production of one charge pair requires somewhat less than 8,500 eV, whereas only 100 eV are necessary for the light excitation of one molecule in its lowest excited state. Even with field strengths of several hundred-thousand volts per cm, saturation of the current was not obtained, contrary to observations with light where saturation was obtained with 10,000 volts per cm. The non-saturation of the current indicates that the positive and negative charges recombine with each other. Author (TAB)

N67-19237# Pennsylvania Univ., Philadelphia.
"CURRENT-STRICTION"—A MECHANISM OF ELECTRO-STRICTION IN MANY-VALLEY SEMICONDUCTORS
Phillipp Kornreich and Herbert Callen Nov. 1966 34 p refs Submitted for Publication
(Contract DA-28-043-AMC-01810(E); Nonr-551(38))
(TR-30; AD-644097) CFSTI: HC $3.00/MF $0.65

Electric fields applied to germanium produce deformations which are about 10,000 times as large as those expected from conventional electrostriction mechanisms. A model is presented which does not involve a polarization in real space but, like the current, is mediated by a shift of the electron distribution in reciprocal space. This field-induced shift increases the energy of the electrons within each valley, but the increase is largest in those valleys with smallest effective mass parallel to the field direction. It then becomes energetically favorable for the lattice to deform in such a way that the deformation potential lowers the energy of the high-curvature valleys at the expense of the low-curvature valleys. The magnitude, temperature-dependence, and angular dependence

of this effect is calculated for n-type semiconductors. A much smaller effect in silicon than in germanium is found in good agreement with the observed magnitudes. The induced strain is a pure volume-preserving linear dilatation in silicon, whereas it is a pure shear in germanium. Author (TAB)

N67-19240 Lockheed Missiles and Space Co., Sunnyvale, Calif.
ANISOTROPIC ELECTRON DISTRIBUTION IN PURE SEMICONDUCTORS IN THE NEIGHBORHOOD OF THE AVALANCHE
R. Granger 18 May 1966 14 p refs Transl. into ENGLISH from Phys. Status Solidi (Berlin), v. 16, 1966 p 599–611
CFSTI: HC$3.00

Electron distribution in pure semiconductors subject to high electric fields is theoretically described, with the impact ionization phenomenon across the forbidden bandwidth taken into account. The distribution is analyzed by considering separately the low and medium energy electrons which are classified as isotropic, and the high energy, or ballistic, electrons traveling in the field direction, in which electrons with energy above the ionization threshold may be found. Two cases of scattering by acoustic or optical phonons are examined. The steady-state electron distribution is separated into three classes, and the probability of transition from one class to another is calculated. The populations of the three classes are obtained as a function of the electron field, and the current–voltage characteristic is deduced. Numerical results are given for several semiconductors, particularly the breakdown fields at different temperatures. It is shown that the time needed for an electron to reach ionization energy is of the same order of magnitude as the relaxation time, while the mean lifetime of the electrons out of equilibrium is much greater. M.G.J.

N67-19267# Georgetown Univ., Washington, D. C.
DC QUENCHING OF AC ELECTROLUMINESCENCE IN ZINC SULFIDE
Edmund Joseph Conway (Ph.D. Thesis) Sep. 1966 157 p refs

The application of a small dc voltage to a moderately insulated phosphor powder during ac electroluminescence decreases the brightness. Quantitative measurements of this effect have been made on time-averaged brightness, brightness waves, and electro-luminescence emission spectra. Room temperature dependences of quenching on ac frequency and on the magnitudes of the ac and dc voltages are reported. A model of the brightness-reducing process is proposed which yields the experimental dependence of quenching on dc voltage. Over most of the dc voltage range, a brightness enhancing process was found to be in competition with the quenching process. The dc voltage dependence of quenching was separated experimentally and an empirical definition of pure quenching is proposed. Author

27 PROPELLANTS

Includes fuels; igniters; and oxidizers. For basic research see: 06 Chemistry; and 33 Thermodynamics and Combustion. For related information see also: 28 Propulsion Systems.

N67-18328*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
THE REACTION BETWEEN OXYGEN DIFLUORIDE AND DIBORANE
R. A. Rhein *In its* Space Programs Sum No. 37–42, Vol. IV 31 Dec. 1966 p 73–80 refs (See N67-18301 08-34) CFSTI: HC$3.00/MF$0.65

Experiments were conducted to qualitatively describe the mechanism for the OF_2/B_2H_6 reaction at partial pressures of 20 torr or less, and at ambient temperatures. Some experiments were made at other temperatures by the following methods: 1) Visual observations were made of the OF_2/B_2H_6 mixture contained in pyrex bulbs while maintaining the bulbs at ambient or lower temperatures; 2) Gas composition as a function of time at ambient temperatures was determined from infrared spectra; and 3) Pressure–temperature relationships of the reacting gas mixtures at low pressures were obtained during a transient heat-up cycle of the mixture contained in a metal reactor. Results show that OF_2 and B_2H_6 react slowly at ambient temperatures and low pressures to produce mostly BF_3 and probably H_2 as volatile products. Mixtures of OF_2 and B_2H_6 can coexist at −195°C, but these mixtures can explode while warming to ambient. When they are heated together, nonvolatile boron compounds, BF_3, H_2, smaller amounts of HBF_2, and possibly B_2F_4 are produced. The reaction of an equimolar mixture of OF_2 and B_2H_6 may be tentatively represented as $3OF_2+3B_2H_6 \rightarrow B_2O_3+2B+2BF_3+9H_2$. R.N.A.

N67-18328*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
LIQUID PROPULSION SYSTEMS
L. R. Toth, R. S. Weiner, O. F. Keller, and H. B. Stanford *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 80–88 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

Recent accomplishments in the development of bladder and expulsion devices for spacecraft liquid propulsion systems are described. These include a new test fixture for studying fluid leaks from metal foil pinholes, permeation leakages through plastics and elastomers, and ethylene–propylene elastomeric diaphragm-type bladder with hydrazine; and the recycling and fabrication of convoluted diaphragms from stainless steel and titanium. R.N.A.

N67-18670 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
COMBUSTION OF ALUMINUM IN SOLID COMPOSITE PROPERGOLS [COMBUSTION DE L'ALUMINIUM DANS LES PROPERGOLS SOLIDES COMPOSITES]
M. Barrere *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 17 (See N67-18661 08-34) CFSTI: $3.00

For improved performance of solid, composite propellants containing ammonium perchlorate crystals, studies are reviewed on specific mass impulse with the addition of aluminum powders. The mechanism and analysis of aluminum drop formation on the surface of propellants are briefly described, as is the combustion of these drops in the hot gases escaping from the propellant surface. Drop ignition and ignition time are also mentioned. This conference reprint ends with summary data on propellant functioning in the presence of aluminum. Transl. by R.U.

N67-19162#, Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Stuttgart (West Germany). Institut fuer Raketentreibstoffe.
HYDRAZINENITRATE-HYDRAZINE AS A MONERGOLIC PROPELLANT, PART I [DAS SYSTEM HYDRAZINNITRAT-HYDRAZIN ALS MONERGOLER TREISBTOFF, TEIL I]
Fritz Bachmaier and Jose Jimenez-Barbera Nov. 1966 28 p refs In GERMAN; ENGLISH summary
(DVL-568; DLR-FB-66-76) CFSTI: HC$3.00/MF$0.65

Theoretical performance calculations show that the specific impulse of the hydrazine monergol may be considerably increased by adding hydrazine-nitrate. Therefore, the data pertinent to rocketery were investigated for solutions of hydrazine-nitrate in hydrazine. The results from these investigations as well as the sensitivity concerning shock and friction of such solutions, are reported. The results obtained indicate the densities and viscosities to behave like ordinary binary systems. With a content of 55 weight % of hydrazine-nitrate, surface tensions show a peak, whereas an eutectic results from thermal analysis at a hydrazine-nitrate-hydrazine ratio

of 48 to 52 weight %. Sensitivities concerning shock and friction lie beneath those of tetryl, picric acid and TNT, i. e. explosives known to be largely insensitive. Further investigations will soon be published in a sequel report. Author

28 PROPULSION SYSTEMS

Includes air breathing, electric, liquid, solid, and magnetohydrodynamic propulsion. For nuclear propulsion see: 22 Nuclear Engineering. For basic research see: 23 Physics, General; and 33 Thermodynamics and Combustion. For applications see: 31 Space Vehicles. For related information see also: 27 Propellants.

N67-18324*# Jet Propulsion Lab., Calif. Inst. of Tech. Pasadena.
GAS-SIDE BOUNDARY PHENOMENA
R. W. Rowley *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 69–73 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

The heat transfer in a spray combustion system was investigated to determine the relationship between injector design and thrust chamber erosion. Some of the physical processes involved in heat transfer between a burning spray and a thrust chamber wall are discussed along with a preliminary correlation of some experimental results. R.N.A.

N67-18331*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
LIQUID MHD POWER CONVERSION
D. G. Elliott, D. Carini, and L. Hays *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 120–131 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

A nonrotating Rankine cycle liquid metal magnetohydrodynamic system is being investigated wherein lithium is accelerated by cesium vapor in a two phase nozzle, separated from the cesium, decelerated in a magnetohydrodynamic generator, and returned through a diffuser and heat source to the nozzle. Results are presented of performance tests of an ac generator with room temperature NaK and of high temperature tests of a lithium heater design. R.N.A.

N67-18332*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PLASMA STUDIES IN THE ELECTRON BOMBARDMENT ION ENGINE
T. D. Majek *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 131–138 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

Results are presented of cesium and mercury electron bombardment ion engine plasma investigations which were conducted to obtain experimental data for use in an analytical model of the plasma. The electron energy distribution based on recent Langmuir probe studies is discussed to show the non-Maxwellian nature of the data and to give reasonable explanations for this distribution. R.N.A.

N67-18412* Northrop Space Labs., Huntsville, Ala.
STATISTICAL ANALYSIS OF THRUST VECTOR CHARACTERISTICS FOR ROCKET ENGINE CLUSTERS
J. W. Bradford, F. L. Echols, J. E. Hilliard, W. E. Hinds, and L. R. Murdock Sep. 1966 237 p
(Contract NAS8-20211)
(NASA-CR-82017; TM-292-6-108; TM-303) CFSTI: HC $3.00 CSCL 21H

This study defines a general solution for determining the statistical properties of the resultant thrust and moment vectors generated by a cluster of rocket engines. Effort was divided into two areas: (1) the derivation of a classical probability solution of the engine cluster problem, supported by a Monte Carlo simulation and (2) the statistical analysis of the resultant vector of actual engine clusters, based on information secured from engine manufacturers, engine and stage alignment personnel, etc. The derivation of a frozen-time classical solution to the engine cluster problem, along with the statistical assumptions made, is given in terms of a three-dimensional coordinate system embedded in the thrust frame and containing the thrust frame centerline as an axis. Extensive field investigations were conducted to obtain statistical and geometrical data on the H-1, J-2, and F-1 rocket engines and the corresponding Saturn stages in which they are used. Statistical models of each of these engines are presented based on static test firings, and complete analyses of the S-I and S-IC stages are given. Close agreement between the classical and Monte Carlo solutions was obtained in both cases. Author

N67-18413* Electro-Optical Systems, Inc., Pasadena, Calif.
STUDY TO DETERMINE THE FLIGHT TEST OBJECTIVES FOR ION PROPULSION SYSTEMS Preliminary Report, 1 Mar–15 May 1961
Ronald S. H. Toms 22 May 1961 283 p refs
(Contract NAS8-1545)
(NASA-CR-82019; EOS-1670-MR-1) CFSTI: HC $3.00 CSCL 21C

A summary of the status of ion propulsion is given, together with a discussion of ion engine testing techniques. Ground testing is described in an appendix, and the limitations of ground testing are discussed extensively in the text, with a detailed survey of the possible effects of the space environment and test conditions on engine operation. Some preliminary analysis of ground and flight measurements for a typical ion engine is given, with recommendations for measurements for the first test. An extensive listing of possible in-flight measurements, and their relation to ground test measurements is given, with an indication of the merits of each measurement. The preliminary conclusion drawn is that the testing of electric propulsion devices in space can probably be completed by two distinct successful tests. The first test would be designed to solve the neutralization problem and a subsequent test should determine the effectiveness of ground simulation of flight conditions. Author

N67-18558# McGill Univ., Montreal (Quebec).
BUSEMANN INLET FOR HYPERSONIC SPEEDS
Sanru Moelder and Edward J. Szpiro *In its* Hypersonic Propulsion Lab. Nov. 1966 2 p refs Repr. from J. Spacecraft and Rockets, v. 3, no. 8, 1966 p 1303–1304 (See N67-18557 08-01) CFSTI: HC $3.00/MF $0.65

Detailed calculations of conditions in an axisymmetric internal flow, consisting of an isentropic compression followed by a free-standing conical shock are presented. Based on the flowfield considerations, a simple method for calculating internal compression inlet geometry and performance has been found. These inlets have very small shock losses and produce a diffused stream that is uniform and parallel to the freestream direction. By tracing streamlines back from the freestream Mach cone, and replacing the streamline sheets by solid surfaces, it becomes possible to generate inlets with swept leading edges. This reduces heat transfer and structural problems, and allows starting in the "no self-start" region of the unswept inlet. A.G.O.

N67-18665 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.

THE SUSTENTATION SYNTHESIS—PROPULSION IN HIGH VELOCITY ATMOSPHERIC FLIGHT [LA SYNTHESE SUSTENTATION—PROPULSION DANS LE VOL ATMOSPHERIQUE A GRANDE VITESSE]

P. Contensou *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 9 (See N67-18661 08-34) CFSTI: $3.00

Aerodynamic forces acting on air fluxes are considered briefly in regard to their useful contribution to propulsion systems and possible application to improved performance of high speed ramjets. The proposed aircraft configuration entailing the high velocity-air flux relationship is then considered for application to long-distance transport aircraft. Transl. by R.Ll.

N67-18671 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.

FUNDAMENTAL RESEARCH ON THE REGRESSION VELOCITY OF LITHERGOLS [RECHERCHES FONDAMENTALES SUR LA VITESSE DE REGRESSION DES LITHERGOLS]

J. F. Lieberherr *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 18 (See N67-18661 08 -34) CFSTI: $3.00

An ablation procedure is reported for a lithergolic engine in which distinction is made between stratified flow and homogeneous flow. A regression rate is established for homogeneous flow and shows that the ablation velocity is proportional to the value of 0.4. The deviation between numerical and theoretical values is over 50%, despite certain approximations. Transl. by R.Ll.

N67-18943*# TRW Systems, Redondo Beach, Calif.

CONVERGENT–DIVERGENT NOZZLE FLOWS

John R. Kliegel and Victor Quan 30 Dec. 1966 78 p refs

(Contract NAS9-4358)

(NASA-CR-65596; TRW-02874-6002-RO-00) CFSTI: HC $3.00/MF $0.65 CSCL 21H

Uniform two-zone perfect gas expansions were studied in convergent–divergent nozzles to determine the appropriate transonic initial conditions for axisymmetric characteristic computer program development. the study resulted in the discovery of a new method of analyzing both uniform and two-zone convergent–divergent nozzle flows and revealed the nature and interrelationship of previous nozzle analyses. The relationship of Hall's transonic solution to the nozzle flow solution presented in this report is pointed out, and uncholed shock free nozzle flow applications are briefly covered. One dimensional channel flow equations for uniform, multistream, and two-zone expansions, and rational fraction approximations are also included. A.G.O.

N67-18954*# Rocket Research Corp., Seattle, Wash.

DEVELOPMENT OF THE SUBLIMING SOLID CONTROL ROCKET, PHASE II

Washington, NASA, Mar. 1967 114 p refs

(Contract NAS5-9070)

(NASA-CR-712) CFSTI: HC $3.00/MF $0.65 CSCL 21H

The development of a flight subliming solid respin rocket system for use on the OV2-1 satellite is described, and results from the rocket nozzle optimization study are discussed. Studies on subliming solid system reliability, low flow rate measurement methods, propellant properties, and characterization of several solenoid valve designs are also covered. The delivery of the rocket system which has a one-year life, 75 lbf-sec total pressure, and weight of 1.67 lbs loaded, is reported, and recommendations regarding recondensation control are given. The fact that throat size has a major bearing on nozzle performance was discovered from optimization research, and reliability results demonstrated that the solenoid valve was the least reliable system component. A.G.O.

N67-18964*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

OFF-DESIGN PERFORMANCE OF TWO ISENTROPIC PLUG NOZZLES DESIGNED FOR A PRESSURE RATIO OF 16.5

Bobby L. Berrier and Charles E. Mercer Washington, NASA, Mar. 1967 38 p refs

(NASA-TN-D-3852) CFSTI: HC $3.00/MF $0.65 CSCL 21E

The performance characteristics of two isentropic plug nozzles on a nacelle model were investigated at static conditions and at Mach numbers of 0.50 to 1.29. Both nozzles were designed to operate at a jet exit Mach number of 2.46 and a jet total-pressure ratio of 16.5. The ratios of throat critical area to maximum cross-sectional area for the two nozzles were 0.25 and 0.22, and the shroud of the nozzle with the smaller area ratio had a larger shroud lip (more projected area normal to the air-stream). The jet total-pressure ratio was varied from 1.0 to approximately 11.0 depending on the Mach number. The results indicate that the large shroud lip nozzle generally exhibits better internal performance and thrust minus drag performance than the small shroud lip nozzle although both exhibit poor performance at transonic speeds. The external flow separation on the nozzle boattail is also shown to have a large influence on nozzle performance. Author

N67-19122* Rocket Research Corp., Seattle, Wash.

DEVELOPMENT OF DESIGN AND SCALING CRITERIA FOR MONOPROPELLANT HYDRAZINE REACTORS EMPLOYING SHELL 405 SPONTANEOUS CATALYST, VOLUME I Final Report

19 Jan. 1967 166 p

(Contract NAS7-372)

(NASA-CR-82457; RRC-66-R-76, Vol. I) CFSTI: HC $3.00 CSCL 21H

The test plan, engine design employed, and test data obtained are presented from a study to develop the empirical scaling formulae necessary for the design of monopropellant hydrazine reactors over a thrust range of 0.5 to 100 lbf. Design and scaling criteria developed are applicable to the design of either rocket engines or gas generators. The development of flightweight 5 lbf engine operating under pulsed and throttled modes of operation and with hydrazine mixtures which have low freezing points is also reported. Included are results from injector optimization tests, catalyst bed design parameter studies, and catalyst degradation measurements. It is noted that the showerhead injector is superior to the rigimesh injector on the basis of smoother operation, and that chamber pressure oscillations encountered during engine testing could be reduced through the use of a layer of fine mesh catalyst on the top of the catalyst bed. A.G.O.

N67-19123*# Rocket Research Corp., Seattle, Wash.

DEVELOPMENT OF DESIGN AND SCALING CRITERIA FOR MONOPROPELLANT HYDRAZINE REACTORS EMPLOYING SHELL 405 SPANTANEOUS CATALYST, VOLUME II Final Report

18 Jan. 1967 99 p refs

(Contract NAS7-372)

(NASA-CR-82458; RRC-66-R-76, Vol. II) CFSTI: HC $3.00/MF $0.65 CSCL 21H

A design manual for monopropellant hydrazine rocket engines and gas generators employing a spontaneous catalyst is represented. The development of theoretical models of reaction chamber operation is covered, and the correlation analysis conducted to develop design and scaling criteria is summarized. Design formulae are presented to define catalyst bed configuration, ammonia dissociation, catalyst bed pressure drop, and chamber pressure response time as a function of reaction chamber design parameters. Design parameters studied include chamber pressure from 50 to 1000 psia, bed loading from 0.01 to 0.045 lbm/in^2-sec, catalyst bed length from that required for satisfactory (smooth) operation to a value which resulted in approximately 85% ammonia

dissociation, and catalyst particle sizes from 1/8"×1/8" cylindrical pellets to 25–30 mesh size granules. An empirical formula which defines the required catalyst bed configuration for smooth, stable, steady state operation as a function of chamber pressure, bed loading, and catalyst particle size is also considered. A.G.O.

N67-19128*# Pratt and Whitney Aircraft, East Hartford, Conn.
DEVELOPMENT OF MAIN SHAFT SEALS FOR ADVANCED AIR BREATHING PROPULSION SYSTEMS Semiannual Report No. 2, 1 Jan.–30 Jun. 1966
R. L. Thomas, A. J. Parks, and R. M. Slayton 9 Sep. 1966 130 p
(Contract NAS3-7609)
(NASA-CR-82453; PWA-2879) CFSTI: HC $3.00/MF $0.65 CSCL 21A

The work accomplished during this 6-month period is outlined. Detailed analytical studies of all seal configurations to be tested were continued. Approval was received for the following seal concepts: orifice compensating hydrostatic face seal and face contact seal with bellows secondary. Procurement of mainshaft seal rig parts of the inert gas rig, and the instrumentation validation rig was completed. Mainshaft seal rig was assembled and the face contact seal with piston ring secondary was run 16 hours while undergoing preliminary dynamic checkout. Build 2 of the face contact seal with piston ring secondary completed 35 hours running time including some test points at 250°F oil in and 800°F air temperature at sliding speeds of up to 400 feet per second. The engine simulation tests of this seal are currently continuing. Author

29 SPACE RADIATION

Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. For related information see also: 13 Geophysics; and 24 Physics, Atomic, Molecular, and Nuclear.

N67-18234*# TRW Systems, Redondo Beach, Calif. Space Sciences Lab.
PLASMA IN THE MAGNETOSPHERE
Frederick L. Scarf 15 Dec. 1966 109 p refs Submitted for Publication
(Contract NASw-1366)
(NASA-CR-81759; TRW-06500-6004-RO-00) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The earth and its magnetic field form an obstacle in the path of the continuously streaming collisionless plasma which represents the outer corona of the sun, and this solar wind compresses and distorts the geomagnetic dipole field into a cavity which is referred to as the magnetosphere. The distorted geomagnetic field appears to extend over a huge tail region in the anti-solar direction, and present estimates of the tail length are on the order of one-thousand earth radii, or more. The magnetosphere contains a very complex distribution of charged particles and it represents a valuable plasma laboratory in which wave propagation, containment, injection, local particle acceleration, plasma instabilities, and other non-linear phenomena can be studied without many of the difficulties and degrading effects encountered in the ground-based laboratory. In this review, we present a summary of some of the more important characteristics of this magnetosphere, and call attention to those areas which appear to be of greatest interest for plasma physics investigations. Author

N67-18242*# Volt Technical Corp., Washington, D. C.
STUDY OF CORPUSCULAR RADIATION ON SPACECRAFT LUNA-10
N. L. Grigorov, V. L. Maduyev, N. F. Pisarenko, and I. A. Savenko 17 Jan. 1967 11 p refs Transl. into ENGLISH from Kosmich. Issled. (Moscow), v. 4, no. 6, 1966 p 842–850
(Contract NAS5-12487)
(NASA-CR-82310; ST-PF-CR-LPS-10553) CSCL 20H

This paper presents the detailed measurement data on cosmic radiations registered aboard the first AMS "LUNA-10". The intensity of primary cosmic radiation in interplanetary space is determined. The albedo for the primary radiation relative to lunar surface has been measured in the orbit of the AMS. Data have been obtained on the fluxes of soft corpuscular radiation in the region of the tail of the Earth's magnetosphere, upholding the preliminary conclusions that have been previously communicated. Author

N67-18353*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE LOW-ENERGY CHARGED PARTICLE ENVIRONMENT OF THE EARTH
W. N. Hess, G. D. Mead, and M. P. Nakada [1965] 66 p refs Submitted for Publication
(NASA-TM-X-57338) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Data on the radiation environment of the earth are reviewed, with emphasis placed on the low energy particles that cause degradation to thermal control surfaces. Protons in the range of 1 KeV to 1 MeV, and electrons up to about 100 KeV, are considered. The measurements obtained from the Explorer, Pioneer, Mariner, and Lunik satellites are assessed in relation to the solar wind, the magnetosphere, the transition zone and shock wave, radiation belts, the aurora, and the low energy particles. Integrated fluxes that can cause significant surface damage are considered, and times to damage for several components of the radiation environment are calculated. A bibliography of references is included. M.G.J.

N67-18358*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
CALCULATION OF DENSITY OF DEFECTS FROM GAMMA IRRADIATION
V. A. J. Van Lint, Felix E. Geiger, Jr., and D. K. Nichols (Gen. Dyn. Corp.) [1965] 7 p refs Submitted for Publication
(NASA-TM-X-57168) CFSTI: HC $3.00/MF $0.65 CSCL 04A

A method for calculating the density of defects to be expected from Compton electrons formed by incident γ-irradiation of a given material is described. The calculation involves experimental knowledge of the rate of introduction of defects, $dN_d/d\phi$, where N_d is the density of defects and ϕ the integrated electron flux, the range–energy curve for electrons, and the theoretical spectrum of Compton electrons given by the Klein–Nishina formula. A specific calculation was made for the density of defects at the band energy level 0.17 eV below the conduction band energy in n-type silicon irradiated by 1.37 MeV Co^{60} γ-rays. Author

N67-18430* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
AN IMPROVED REENTRANT COSMIC RAY ALBEDO CALCULATION
Ernest C. Ray [1965] 19 p refs Submitted for Publication
(NASA-TM-X-57252) CFSTI: HC $3.00/MF $0.65 CSCL 20H

An earlier calculation of the intensity of reentrant albedo is repeated. An error in the previous calculation is corrected and the effects of nuclear interactions and the spiralling of trajectories are included. Improved fits to the altitude dependence of primary protons and to the Bethe Block formula are used. The previously computed value of the reentrant albedo intensity was $j = 1.17$ $(m^2 sec\ sterad\ MeV)^{-1}$ or $j = 0.47 (m^2 sec\ sterad\ MeV)^{-1}$, both at 85 MeV during December 1961 at Sioux Falls, South Dakota. The improved value obtained in the present paper is $j = 0.41 (m^2 sec\ sterad\ MeV)^{-1}$ under the same conditions as for the previous calculations. Both calculations have omitted the contributions to the intensity of deuterons and tritons. Author

N67-18481# California Univ., Berkeley. Dept. of Physics.
ENERGETIC PARTICLES IN THE EARTH'S MAGNETIC FIELD
Kinsey A. Anderson Mar. 1966 102 p refs
(NP-16319)

Theoretical and experimental investigations of the Earth's radiation zones are discussed. Information is given on sources of geomagnetically trapped charged particles. Discussions are also included on the Earth's magnetic field, motion of trapped particles, precipitation of particles into the atmosphere, particle distribution and lifetimes, and temporal features of auroral zone particle precipitation. NSA

N67-18510*# Naval School of Aviation Medicine, Pensacola, Fla.
A NOTE ON THE GALACTIC RADIATION EXPOSURE IN GEOMAGNETICALLY UNPROTECTED REGIONS OF SPACE
Hermann J. Schaefer 28 Oct. 1966 19 p refs Joint Report with NASA
(NASA Order R-75)
(NASA-CR-82018) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Measurements of the galactic flux at low rigidities during the Years of the Quiet Sun 1964–65 indicate that the galactic radiation is still modulated at solar minimum with the differential flux at low rigidities strongly depressed. Thus it is assumed that, in space systems of low shielding, no exceptionally large skin doses in a human target will result. This is quite different from that occurring from trapped radiation and solar particle beams. A conservative estimate for the total dose from galactic radiation at solar minimum including secondaries for 2π incidence is 50 millirads/24 hours with 5 to 8 per cent of this dose produced by high LET components. If life shortening is used as criterion for long term effects, the quoted exposure corresponds to a factor of 0.2 in the sense that 100 days of exposure would shorten the residual life span by 20 days. Author

N67-18631*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
PROPAGATION OF COSMIC RAY NUCLEI IN INTERSTELLAR SPACE AND SOLAR SYSTEM
N. Durgaprasad Sep. 1966 45 p refs
(NASA-TM-X-55674; X-611-66-446) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The propagation of cosmic ray nuclei in interstellar space and the solar system was studied with special reference to the recent data obtained on the various components of the cosmic radiation, using balloons, satellites and rockets. The following source spectra were assumed in the analysis: power law spectra in total energy per nucleon, and kinetic energy per nucleon and in rigidity. The constants and the exponents of these spectra were deduced from the high energy data that is little affected by solar modulation. The effective path length, x, in g/cm^2 traversed by the nuclei, was determined as a function of energy from a study of the variation of charge ratios of nuclei of charge $Z \geq 20$, $Z \geq 10$, $Z = 3-5$ and α-particles. It was found that this path length traversed decreased with decreasing energy, consistent with a model $x = \beta c \rho t = \beta x_0$ where x_0 is the high energy value of matter tranversed, βc is the velocity of the nucleus, ρ is the average density of matter and t is the age of the nuclei. Two mechanisms of modulation, the heliocentric electric field model and the generalized Parker's model, were used to study the temporal variations. It was found that the generalized Parker's model would explain the intensity variations over the period considered for all the components of the cosmic radiation using the source spectrum that is a power law in rigidity. The parameters involved in this model deduced for various years were found to be consistent with the values deduced by Parker from general dynamical theory of the solar wind and recent space observations. Author

N67-18634* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
STELLAR AND SOLAR FLARES
E. Schatzman (Inst. d'Astrophys., Paris) Dec. 1966 17 p refs Lecture Given at Greenbelt, Md., 4 Nov. 1966
(NASA-TM-X-55697; X-640-66-565) CFSTI: $3.00 CSCL 20H

Ideas concerning solar flares which have been already presented by the author are developed. The insistence is put on the problem of energy transport from the energy supply to the region of the optical flare, on the storage of low energy cosmic ray particles in a magnetic bottle before the beginning of the optical flare, and on the mechanism which triggers both the optical flare and the production of high energy cosmic rays. The relation between solar and stellar flares is considered. Author

N67-18704*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
A TOPOLOGICAL STUDY OF THE MOTION OF PARTICLES TRAPPED IN A MAGNETIC FIELD
Ernest C. Ray [1963] 15 p refs Submitted for Publication
(NASA-TM-X-57232) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The possible existence of magnetic fields is explored for the curves representing the adiabatic integral invariant (J) that are constant and a family of spirals. A necessary condition for this is that J=exists as a constant spiral surface so that a particle spiralling around it does not usually drift off the surface, since J would suffer a discontinuity as a particle crossed it. It is then shown that no family of curves for J=constant can be a family of spirals, for which through each point in the alpha, the beta space passes exactly one member of the family. Since one member of the family passes through each point, no member intersects either itself or any other member. It is considered unlikely that any reasonable model of the earth's magnetic field possesses any of the properties that permit the set of curves J=constant to be a spiral, or that any such fields can be constructed; and before a model can be attempted, the existence of the magnetic field that produces a spiral family of curves J=constant must be proven. M.W.R.

N67-18710*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt Md.
GREENHOUSE EFFECT IN SEMI-INFINITE SCATTERING ATMOSPHERES
R. E. Samuelson [1965] 53 p refs Submitted for Publication
(NASA-TM-X-57083) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The method of discrete ordinates is extended to describe the steady state intensity distribution of thermal radiation and the corresponding depth-dependent thermal structure of a plane-parallel semi-infinite particulate medium in radiative equilibrium in the presence of an outside point source of visible radiation. The greenhouse factor $(B(\tau)/F(0))$ is found to approach a finite limit as $\tau \to \infty$. Numerical calculations show that the diffuse field or visible radiation generated by multiple scattering processes is extremely effective in heating the lower regions of a particulate atmosphere. For slightly more realistic single scattering parameters than those considered in this study, it would appear that the large differences in temperature between the surface and the effective level of infrared radiation of Venus, as inferred from the infrared and microwave observations, can be mostly accounted for. Neither high surface pressures nor internal heat sources are required to make the heating mechanism work effectively. Author

N67-18713*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
ELECTRON AND PROTON FLUXES IN THE TAIL OF THE MAGNETOSPHERE
Andrei Konradi Nov. 1965 26 p refs Submitted for Publication
(NASA-TM-X-57080; X-611-65-485) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Observation and energy spectra of electrons and protons in islands at the back of the magnetosphere are shown to be typically for electrons $J(>2\ KeV) \leq 8 \times 10^6/cm^2\text{-sec-ster}$, and for protons $J(>125\ KeV) < 10^4/cm^2\text{-sec-ster}$. The electron spectra for particles with $20\ kev < E < 70\ KeV$ can be characterized by e-folding energies ranging from 15 to 5 KeV or by γ from 2.6 to 4.3 for differential power law spectra. For protons with energies $E > 125$ KeV the spectra display e-folding energies in the range from 20 to 40 KeV for γ between 7.8 and 4.9. The electron spectra in the islands show a characteristic softening with time. A comparison is made with electron fluxes observed with the Alouette, IMP-1, and Vela satellites. The similarity between particles in the islands and those observed in the aurora is discussed. Author

N67-18715*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
REMARKS ON PAPER BY K. G. IVANOV
Norman F. Ness [1965] 8 p refs Submitted for Publication
(NASA-TM-X-57079) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Data from both IMP-1 magnetic field and plasma measurements are presented to substantiate the existence of a lunar lee wake. A direct computation of the average Alfven number indicates super Alfvenic flow that precludes the possibility of any disturbance propagating upstream from the geomagnetosphere. It is, therefore, concluded that this supports the interpretation of an observed interplanetary phenomenon as the wake of the moon in the flow of the solar wind. M.W.R.

N67-18751*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
OGO-E COSMIC RADIATION—NUCLEAR ABUNDANCE EXPERIMENT
S. L. Jones, G. H. Ludwig, D. E. Stilwell, J. H. Trainor, and S. H. Way Nov. 1966 25 p ref Presented at the 13th IEEE Nucl. Sci. Symp., Boston, 19–21 Oct. 1966
(NASA-TM-X-55692; X-611-66-537) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Information on the detailed charge and energy spectra of galactic and solar cosmic rays is required for a better understanding of the production, acceleration, and modulation of those cosmic rays. This experiment consists of a set of three detector assemblies to measure the differential energy spectra of protons and heavier nuclei through calcium ($Z=20$) in the range of 400 Kev to 1 BeV/nucleon. This includes an extensive electronics system to implement the logic, perform pulse height analysis, measure particle fluxes, monitor experiment performance and interface with the OGO data system. Author

N67-18772 Consultants and Designers, Inc., Arlington, Va.
ON THE RELATIONSHIP OF X-RAY EMISSION OF SOLAR FLARES WITH THEIR EFFECTS IN COSMIC RAYS [O SVYAZI RENTGENOVSKOGO IZLUCHENIYA SOLNECHNYKH VSPYCHEK S IKH EFFEKTAMI V KOSMICHESKIKH LUCHAKH]
E. M. Vladimirskiy and A. K. Pankratov 17 Feb. 1965 15 p refs Transl. into ENGLISH from Izv. Krymsk. Astrofiz. Observ. (Moscow), v. 32, 1964 p 46–55
(Contract NAS5-3760)
(NASA-TT-F-9643; ST-SP-CR-AI-10293) CFSTI: HC $3.00/MF $0.65 CSCL 20H

From the comparison of ionospheric effects of flares with small increase in cosmic ray intensity (less than one percent) at sea level (nucleon component), the following conclusions are drawn. More powerful effects in the D-layer of the ionosphere correspond, as an average, with more substantial increases of cosmic ray intensity at sea level. The appearance of absorption in the D-layer constitutes a necessary but not sufficient indication of the occurrence of a small effect in cosmic rays at sea level. Author

N67-18907 Lockheed Missiles and Space Co., Palo Alto, Calif.
ON THE THEORY OF RADIATION TRANSFER IN AN INHOMOGENEOUS MEDIUM
V. V. Zhelezniakov [1966] 9 p refs Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved., Radiofiz. (Gor'kiy), v. 9, no. 6, 1966 p 1057–1064

The known equation of radiation transfer in an inhomogeneous medium is obtained by starting from the continuity equation for the density of radiation energy in a space of coordinates and group velocity directions. The inconsistency of the theory of transfer in an inhomogeneous medium proposed by Oster and the inadmissibility of its application by Oster and Sofia to the investigation of the radio emission from the quiet sun are shown. Author

N67-18957*# Volt Technical Corp., Washington, D. C.
IRREGULAR VARIATIONS OF EARTH'S ROTATION VELOCITY AND ACTION OF SOLAR CORPUSCULAR STREAMS ON THE EARTH'S MAGNETOSPHERE [IRREGULYARNYYE IZMENENIYA SKOROSTI VRASHCHENIYA ZEMLII VOZOEYSTVIYE SOLNECHNYKH KORPUSKULYARNYKH POTOKOV NA SHLEYF ZEMNOY MAGNITOSFERY]
V. I. Afanas'yeva 20 Jan. 1967 5 p refs Transl. into ENGLISH from Geomagnetizm i Aeronomiya (Moscow), v. 6, no. 6, 1966 p 1094–1095
(NASA-CR-82436; ST-PF-GM-10555) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The author attempts to explain the irregular variations of the Earth's rotation velocity by action of solar corpuscular streams on the Earth's magnetosphere, in particular on its tail, by discussing the position of the magnetosphere tail for various geomagnetic conditions, and then referring to the daily observation data collected between 1961 and 1963. A conventional parameter is computed on the basis of these data, and it is found that its behavior in all the cases considered was of same order, independently from the objectives of the current note. The main argument in favor of the hypothesis brought forth is the accounting for the noncoincidence in the direction of the magnetic field of the stream and of the geomagnetic field in the tail, which is characterized by a certain asymmetry due to universal geomagnetic anomalies. Author

N67-18958*# Volt Technical Corp., Washington, D. C.
VARIATIONS OF COSMIC RAYS ACCORDING TO THE DATA OF INTERPLANETARY PROBES ZOND-3 AND VENUS-2 [VARIATSII KOSMICHESKIKH LUCHEY PO DANNYM STANTSIY ZOND-3 I VENERA-2]
S. N. Vernov, A. E. Chudakov, P. V. Vakulov, Yu. I. Logachev, G. P. Lyubimov et al 27 Dec. 1966 8 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSR, Geofizika (Moscow), v. 171, no. 3, 1966 p 583–586
(Contract NAS5-12487)
(NASA-CR-82437; ST-CR-PF-IS-10550) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The intensity variations of cosmic rays are measured by the counters of Zond-3 and Venus-2; these probes moving in different directions allow to account for their temporal variations and to determine their radial gradient. To explain the radial gradient of protons with energy 1÷5 Mev, detected by the probes' apparatus, and of which the temporal character is ruled out, various mechanisms are proposed, which concern both the galactic and solar origin of these protons. Author

N67-18984*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
THE FLUX OF HEAVY NUCLEI IN THE PRIMARY COSMIC RAYS OVER TEXAS IN MARCH 1962, AND THE SOLAR CYCLE MODULATION

S. Biswas, D. A. Kniffen, and K. A. Neelakantan Feb. 1967 28 p refs
(NASA-TM-X-55706; X-611-67-52) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The fluxes of heavy nuclei with $Z \geq 6$ in the primary cosmic radiation were measured with a nuclear emulsion stack exposed in a balloon flight, and the fluxes of $M(6 \leq Z \leq 9)$ and $H(Z \geq 10)$ nuclei extrapolated to the top of the atmosphere were found to be 6.20 ± 0.46 and 2.02 ± 0.25 particles m^2 ster sec, respectively. Results of this work and those of other investigations made during the last solar cycle (1954–1964) are used to study the long term solar modulation of primary S-nuclei ($Z \geq 6$) of rigidity ≥ 4.8 Bv. It is found that the lag between the primary intensity changes and the sunspot number is about one and a half years during the increasing phase of solar activity and is very small during the declining phase of solar activity. This is in agreement with the changes of the spectral shape during the solar cycle as suggested by Simpson. The implication of the time lag in terms of the scale size of the transition region of the magnetic field responsible for the long term modulation is briefly discussed. Author

N67-19025*# National Aeronautics and Space Administration, Washington, D. C.
PARTICLES AND FIELDS
Alois W. Schardt and Albert G. Opp *In its* Significant Achievements in Space Sci., 1965 1967 p 31–88 refs (See N67-19022 08-30) GPO: HC $3.00; CFSTI: MF $0.65

Space data pertaining to particles and fields is described in terms of a multidimensional matrix involving time of observation, spatial position, and type of observation. Correlations between measurements by Mariner IV and OGO I permitted the first direct study of the spatial extent of solar proton events. The penetration of galactic cosmic rays into the solar system was studied, further exploration of the magnetosphere was made, and planetary magnetism was investigated. Progress was made in the study of supersonic expansion of the solar corona, plasma properties of the solar wind, and the detailed energy spectra as a function of arrival direction relative to the Earth–Sun line. The magnetosphere is considered with respect to the magnetosheath, the structure and stability of the bow shock and magnetospheric boundary, and the magnetospheric tail. Isolated solar flares and the subsequent propagation of the energetic protons through the undisturbed interplanetary medium were analyzed, and experimental observation of the anistropy of the solar proton flux near Earth were made. Galactic cosmic rays were studied in light of a theroretical model of the solar wind to obtain a quantitative understanding of the solar modulation and to derive the cosmic ray flux outside the galaxy. S.P.

N67-19028*# National Aeronautics and Space Administration, Washington, D. C.
SOLAR PHYSICS
P. J. Dickerman (IIT Res. Inst.) and H. J. Smith *In its* Significant Achievements in Space Sci., 1965 1967 p 197–218 refs (See N67-19022 08-30) GPO: HC $3.00 CFSTI: MF $0.65

Research related to solar astronomy, the sun's characteristic radiation, and examination of the solar spectrum at all wavelengths is presented. Satellites were launched to observe the Sun and solar-terrestrial relationships and to take advantage of the quiet solar conditions in 1965. A number of sounding rockets were flown and an airplane expedition observed from the stratosphere the International Quiet Sun Year total solar eclipse. Numerous observations of the shape, color, brightness, and polarization of the Sun's corona were made; and telescopes, spectrographs, and photometers were developed for application to radiation from the Sun. Data were obtained for the extreme ultraviolet spectrum of the quiet Sun (below 300 Å), providing both center-limb variations and semiabsolute photometric measurements. Satellites provided data for understanding the X-ray emission of flares as well as additional measurements of the Sun's flux at times of various levels of overall solar activity. Significant advances were also made in application of infrared detector technology to solar observation. S.P.

N67-19045*# Yale Univ., New Haven, Conn.
INTERPLANETARY SCINTILLATION IN JOVIAN DECAMETRIC RADIATION
James N. Douglas and Harlan J. Smith [1966] 51 p refs
(Grants NsG-407; NSF GP-4086)
(NASA-CR-82374) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Spaced-receiver observations over four oppositions establish the origin of the one-second component of time-structure in Jupiter's decametric emission as diffraction by inhomogeneities in the solar wind moving radially outward from the sun. Arguments from simple diffraction theory suggest inhomogeneity correlation scale sizes ranging from a few hundred to a few thousand kilometers, and set an upper limit on the intrinsic angular size of Jupiter's decametric source at about 5". Author

N67-19047*# Yale Univ., New Haven, Conn.
NO TITLE Final Report, Mar. 1957–May 1966
James N. Douglas 20 Dec. 1966 5 p ref
(Grant NsG-407)
(NASA-CR-82376) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The status of a research program to study Jupiter's decametric emission is presented. Investigations of the emission characteristics, polarization properties and space-receiver observations of time structure of Jupiter's decametric emission are reviewed. A brief description of the decameter monitoring system is also included. S.P.

N67-19113* Yale Univ., New Haven, Conn.
SPACE RECEIVER OBSERVATIONS OF JOVIAN DECAMETER FLUX Progress Report
Louis Pataki [1966] 7 p
(Grant NsG-407)
(NASA-CR-82654; PR-3) CFSTI: $3.00 CSCL 03B

A third flux monitoring station was set up which led to confirmation of the velocity of the interplanetary electron clouds responsible for the second long I-pulses. The addition of this station has led to a study of the direction of this motion, and will allow the calculation of the shape of the irregularities in the interplanetary medium. Described are techniques used to analyze either spherical or randomly oriented irregularities causing the L-pulses. As a basis for first analysis the contours of correlation are treated as circular. Data on the directions of the velocity vector in the plane perpendicular to the line of sight of Jupiter are presented for the event of October 23, 1965. Velocity data obtained from the three stations was in agreement. This indicates that even if the correlation contours are elliptical and not strictly circular, their motion is not such as would give a misleading projected velocity between two stations. An extension of the theory derived for ionospheric work and its casting in a form suitable for computer analysis is under way. This will allow calculation of the shape of the correlation contours and thus of the mean shape of the irregularities in the interplanetary medium. Records are being digitized for this purpose. It is surmised that their analysis will give data at various values of hour angle and Jovian longitude thus allowing a careful analysis of the interaction of the L-pulse phenomena with other astronomical parameters. S.C.W.

30 SPACE SCIENCES

Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis of orbit and trajectory. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles.

N67-18201* Volt Technical Corp., Washington, D. C.
THE SERIES OF POLYNOMIALS IN THE PROBLEM OF THREE BODIES

V. A. Brumberg 12 Dec. 1966 29 p refs Transl. into ENGLISH from Byul. Inst. Teor. Astron. (USSR), v. 9, no. 107, 1963 p 234–256
(Contract NAS5-12487)
(NASA-CR-81795; ST-CM-10544) CFSTI: $3.00 CSCL 03C

The problem of three bodies converging for any real moment of time is investigated by numerical methods. The convergence coefficients, which transform the Taylor series with some finite convergence circle in a series of polynomials converging for any point within the Mittag-Leffler rectilinear star of generative function are given. Such power-polynomial series by mean anomaly are constructed for the elliptic three-body problem. For the sake of comparison, the Sundman series, related to the same problem, are analyzed. Finally, the series of power-polynomials by the variable regularizing the double collisions is dealt with. Author

N67-18218#
QUALITATIVE METHODS IN THE n-BODY PROBLEM
H. Pollard [1966] 57 p

The n-body problem concerned with the motion of masses moving in inertial space under the attraction of their gravitational forces is considered. The illustrative central force problem analyzed is a 2-body problem with masses moving in a field subject to the inverse square law. The equations of motion are then given for an n-body problem under an arbitrary law f(r). The concept of the Tauberian condition required to obtain reversibility in a given asymptotic function is also presented. S.P.

N67-18239* California Univ., San Diego.
ON THE WAVELENGTHS OF ABSORPTION LINES IN QUASI-STELLAR OBJECTS
Geoffrey Burbidge 1 Dec. 1966 10 p refs Submitted for Publication
(Grant NsG-357)
(NASA-CR-81797) CFSTI: $3.00 CSCL 03B

Of several quasi-stellar objects with red-shifts greater than z = 1.9, only five showed absorption lines of very close coincidence. Two objects, 3C 191 and PKS 0237-23, showed thirteen lines which coincided within 3 Å in the mean; the other three objects exhibited only a few absorptions when allowances for wavelengths differences were made. G.G.

N67-18243*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
CONDITIONS OF ENCOUNTER BETWEEN DUST AND THE PLANETS
Curtis W. McCracken [1965] 33 p refs Submitted for publication
(NASA-TM-X-57225) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The conditions of encounter between interplanetary dust particles and the planets are investigated for the range of particle size where the force of solar radiation is not negligible in comparison with the force of solar gravity. The action of solar radiation pressure in reducing the heliocentric orbital speed of a small dust particle makes possible very low planetocentric speeds at encounter for an entire class of heliocentric orbits of non-zero eccentricity and fairly low inclination. The speed at encounter and the apparent radiant depend on the size of the dust particle for a given heliocentric orbit throughout the range of particle size being investigated by means of dust particle sensors mounted on spacecraft. Author

N67-18273*# National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York.
THE ATMOSPHERE OF MERCURY
S. H. Gross (Airborne Instr. Lab.), W. E. McGovern, (N. Y. Univ.), and S. I. Rasool Jan. 1966 54 p refs Submitted for Publication
(Grant NSG-499)
(NASA-TM-X-57322) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Available information on the temperature, composition, and surface pressure of Mercury's atmosphere is reviewed and the implications of a nonsynchronous rotation of the planet on the atmosphere are discussed. Several atmosphere models consistant with observations are constructed in an attempt to determine if they are stable against depletion of the atmosphere by gravitational escape. Results are discussed from the viewpoint of the atmospheric surface. R.N.A.

N67-18280*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ON THE LIMB DARKENING OF PLANETARY ATMOSPHERES IN THE THERMAL INFRARED
Robert E. Samuelson [1965] 12 p refs Submitted for Publication
(NASA-TM-X-57359) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Thermal maps of Venus and Jupiter have demonstrated that limb darkening in the 8 to 14 micron wavelength interval is pronounced for these two planets. Since both planets are completely cloud covered, it is possible that both anisotropic multiple scattering and a temperature gradient are responsible. An attempt is made to demonstrate how exact solutions to the standard problem, that of describing the angular distribution of outgoing radiation from a slab of material bounded on both sides by a vacuum, may be expressed in terms of Chandrasekhar's ψ and ϕ functions of zero order when both scattering and temperature gradient effects are present. Author

N67-18303*# Jet Propulsion Lab., Calif. Inst. of Tech. Pasadena.
CORRECTIONS TO THE LUNAR EPHEMERIS
J. D. Mulholland *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 2–5 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

Research focusing on improving the adequacy of the lunar ephemeris as it is contained in the JPL ephemeris tapes is reported. Discussed are the nature and implications of modifications being made to the lunar ephemeris which are divided into four categories. These categories are identified as being due to improvements in: (1) coordinate transformations, (2) basic theory, (3) the treatment of abberation, and (4) astronomical constants. The most important aspect of changing the lunar ephemeris is that the new ephemeris will place the Moon at a different location. Included is a discussion of two problems associated with changing the lunar ephemeris and discussion of the value of the corrected ephemeris. S.C.W.

N67-18311*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
NUMERICAL INTEGRATION OF PERIODIC ORBITS IN THE ELLIPTIC RESTRICTED THREE-BODY PROBLEM
R. Broucke *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 31–34 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

The problem of finding symmetric periodic orbits in the elliptic restricted three-body problem with Earth–Moon mass ratio and Earth–Moon eccentricity was studied. Presented are a family of periodic orbits which all have the same period as the Earth and the Moon, and which all correspond to the Earth–Moon mass ratio, and have the eccentricity as the variable parameter. These orbits were computed for the eccentricities from 0 to 0.5, starting with an orbit with eccentricity zero found in the circular problem. Differential corrections were also made to increase the eccentricity. All programs prepared are three-dimensional, although the periodic orbits presented are two-dimensional. The programs are for any eccentricity from 0 to 1 and any mass-ratio from 0 to 1. Numerical integrations were done with a recurrent power series method. S.C.W.

N67-18355*# National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York.
ASTROPHYSICAL EVIDENCE FOR THE DIRECT ELECTRON-NEUTRINO WEAK INTERACTION

Chao-wen Chin, Hong-yee Chiu, and Richard Stothers [1965] 42 p refs Submitted for Publication
(NASA-TM-X-57356) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Observational evidence exists that central stars of planetary nebulae are evolving into white dwarfs. However, a gap in the stellar population appears between the faintest central stars (100 $L_\odot$) and the brightest white dwarfs (1 $L_\odot$). Theoretical models of superluminous white dwarfs (Gap stars) are constructed with and without the inclusion of neutrino emission processes. Neutrino emission is known to speed up stellar evolution. The evolution of stars in the mass range 0.7 $M_\odot$ to 1.1 $M_\odot$ was found to be accelerated by a factor of 10 to 100 if plasma neutrino emission is included. The larger Gap stars can be identified by their blue color. An upper limit to their evolution time is obtained from a variety of observational arguments. This limit is 5×10^5 years as compared with theoretical lifetimes of 2×10^5 years with neutrino emission and 2×10^8 years without it. From these results it is concluded that the plasma neutrino energy loss rate roughly reproduces the astronomical data, and the weak interaction coupling constant for the $(e\nu_e)$ $(e\nu_e)$ interaction has a lower limit close to the currently accepted value. There is also evidence that neutrino emission may be accelerating evolution in central stars. R.N.A.

N67-18356*# National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York.
GRAVITATIONAL COLLAPSE AND WEAK INTERACTIONS
W. David Arnett [1966] 102 p refs Submitted for Publication
(NASA-TM-X-57354) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The behavior of a massive star during its final catastrophic stages of evolution has been investigated theoretically, with particular emphasis upon the effect of electron-type neutrino interactions. The methods of numerical hydrodynamics, with coupled energy transfer in the diffusion approximation, were used. Gravitational collapse initiated by electron capture and by thermal disintegration of nuclei in the stellar center is examined, and the subsequent behavior does not depend sensitively upon which process causes the collapse. Author

N67-18359*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
PAYLOAD TO MARS RECONNAISANCE ORBIT USING PRESENT AND FUTURE BOOSTER SYSTEMS
C. A. Wagner Washington, NASA, Feb. 1967 71 p refs
(NASA-TM-X-1334) CFSTI: HC $3.00/MF $0.65 CSCL 22C

A basic simplified technique of calculating mission payload weights is derived from first principles. Using this method, a number of booster and upper stage systems are examined for their capability of placing useful payloads into Mars orbit in the period 1966–1969. It is found that with present operational systems, payloads of 100 to 300 pounds may be placed in favorable orbits for continuously observing conditions on and near Mars and relaying this information back to earth. Preliminary comparison of performance capabilities of low thrust, radioactively powered versus conventional chemical Mars stage propulsion systems indicates that the low thrust–high performance systems offer little payload advantage for Mars orbiter spacecraft of 500 pounds or less. However, using a Titan II/Agena D booster, a two- or three-stage low thrust system employing a high thrust Mars injection engine could place 800 to 1000 pounds in a favorable eccentric Mars orbit with a synchronous period and a minimum altitude of 1000 kilometers, compared with 650 to 800 pounds for a one-stage chemical system. Author

N67-18360*# National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York.
THE EVOLUTION OF THE SUN
Hong-Yee Chiu [1965] 31 p refs Submitted for Publication
(NASA-TM-X-57357) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The various stages and processes in the evolution of the sun are described. The discussion covers the formation of the sun and planets, the Hertzsprung-Russell diagram (a plot of luminosity against surface temperature for stars) which is used to discuss the history and future evolution of the sun, the condensation of the solar nebula to form the proto-sun, the sun as a nuclear furnace, hydrogen exhaustion of the sun and transition into a red giant, helium reaction and ultimate fate of the sun, and finally the sun's evolution into a planetary nebula and then a white dwarf. R.N.A.

N67-18385# Royal Observatory, Edinburgh (Scotland). Satellite Tracking Section.
IDENTIFICATION OF SATELLITES ACQUIRED UNEXPECTEDLY
R. D. Eberst 20 Oct. 1966 5 p refs Supersedes Rept.-53
(Rept.-53a; Rept.-53) CFSTI: HC $3.00/MF $0.65

The increase in the number of objects in orbit about the earth has led to a corresponding increase in the number of instances of satellite observers unexpectedly acquiring an unidentified satellite. This paper gives the cinetheodolite observer a method of provisionally identifying the object observed. The method can be adapted for use by an observer using the star background for position determination. Author (ESRO)

N67-18435* National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York.
EARTH AND VENUS—THE SISTER PLANETS?
R. Jastrow and S. I. Rasool Feb. 1966 32 p refs Submitted for Publication
(NASA-TM-X-57351) CFSTI: $3.00 CSCL 03B

Various features of Venus, including its climate, surface temperature, atmosphere, greenhouse effect, radiation, CO_2 and water vapor content, surface characteristics derived from radar observations, and rotation are discussed and compared with those of the Earth. R.N.A.

N67-18490* Volt Technical Corp., Washington, D. C.
CURRENT PROBLEMS OF MORPHOLOGY OF MOON'S SURFACE [TEKUSHCHIYE PROBLEMY MORFOLOGII POVERKHNOSTI LUNY]
Yu. N. Lipskiy, Yu. P. Pskovskiy, A. A. Gurshteyn, V. V. Shevchenko, and M. M. Pospergelis 20 Dec. 1966 17 p refs Transl. into ENGLISH from Kosmich. Issled. (Moscow), v. 4, issue 6, Nov.–Dec. 1966 p 912–922
(Contract NAS5-12487)
(NASA-CR-82093; ST-LPS-10547) CFSTI: $3.00/MF $0.65 CSCL 03B

A preliminary analysis is presented of the characteristics of the lunar surface as determined by photographs taken by the automatic interplanetary station Zond III. Data are included on the morphological study of the lunar crust to determine the distribution of continential and mare regions. Specific depressions, hundreds of kilometers in diameter, are reported for the invisible hemisphere of the moon; and these depressions, comparable in area with lunar maria, are described by the term "thalassoid." Two types of annular depressions are noted, and both are referred to as basins. Characteristics of the various types of formations are described, particularly those discovered on the far side of the moon. M.W.R.

N67-18577*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
MEASUREMENTS OF INTERPLANETARY DUST PARTICLE FLUX FROM EXPLORER XVI CdS AND WIRE GRID DUST PARTICLE DETECTORS
Luc Secretan Sep. 1966 34 p refs Presented at the Symp. on Meteor Orbits and Dust, Boston, 9–13 Aug. 1965 Submitted for Publication
(NASA-TM-X-55676, X-813-66-451) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The CdS dust particle detectors on Explorer XVI determine flux of dust particles in the vicinity of the earth by measuring the area of the perforations due to impacts of dust particles of mass $\geq 10^{-10}$ gm through a 1/4 mil aluminized mylar film. One CdS detector measured a total area of 0.08 mm^2 perforated by dust particles over a 55-day period; the other measured an area of 0.0068 mm^2 in 20 days. The perforated area is proportional to the cumulative flux of impacting particles of mass $\geq 10^{-10}$ gm. The flux measured by the detectors is compared with several models provided by other satellite observations and various ground based observations. Approximately 10^3 impacts are predicted by a flux model derived from direct satellite measurements, and the area opened up by these impacts agrees with results of the CdS detector experiment. Flux models derived from ground based observations predict too few impacts for the mass range of particles considered here. A wire grid sensor that detects particles of mass 10^{-7} gm and larger provides data in good agreement with the dust particle flux model derived from direct satellite measurements. Author

N67-18578*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
ON THE FORMATION OF GRAPHITE GRAINS IN COOL STARS
B. Donn, T. P. Stecher, N. C. Wickramasinghe (Md. Univ.), and J. P. Hudson (Rensselaer Polytechnic Inst.) 21 Sep. 1966 38 p refs Submitted for Publication
(NASA-TM-X-55677; X-613-66-456) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Conditions for graphite grain formation in cool stars are examined on the basis of recently available molecular equilibrium data for stellar atmospheres. The Hoyle-Wickramasinghe mechanism for condensation in N stars was re-examined taking into account the presence of H, O, and N; and from Tsuji's tables, the partial pressure of free carbon in an N star is found to exceed the vapor pressure of bulk graphite when the temperature falls below 2400°K during a pulsation cycle. Using classical nucleation theory, it is shown that the supersaturation p/p_{sat} required for graphite condensation on pre-existing ions in the stellar atmosphere is only ≈ 2.2 and is reached when the temperature falls to ≈ 2300°K in an N star. Crystal growth proceeds sufficiently fast at the free carbon pressures appropriate for temperatures greater than 1500°K to produce grain sizes exceeding 10^{-5} cm. The actual size to which particles grow is however restricted by the amount of available carbon and the number of effective condensation nuclei. Graphite condensation may take place to a limited extent in a region of the stellar atmosphere where the temperature falls to about 1600°K provided the effective C/O ratio is 1.3. Author

N67-18579*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
HARMONIC HARMONIC L_4 ORBIT FOR THE VERY RESTRICTED FOUR-BODY PROBLEM
Ronald Kolenkiewicz and Lloyd Carpenter Jul. 1966 21 p refs Submitted for Publication
(NASA-TM-X-55664; X-643-66-298) CFSTI: HC $3.00/MF $0.65 CSCL 03C

A method of general perturbations employing Chebyshev series is used to investigate motion in the vicinity of the L_4 triangular point of the earth-moon system. The model used is that of the very restricted four-body problem for the earth-moon-sun system. A harmonic orbit, in the numerical sense, with respect to a rotating coordinate frame centered at L_4 is found. The period of this harmonic orbit is equal to the period of the disturbing force and is the same as the moon's synodic period. This orbit remains within 6860 km of the L_4 point; and describes two different size loops about L_4, the smaller one traversed in 36% of the period. The disturbing force gives rise to another orbit about L_4, and both force and orbit are nearly periodic with half the moon's synodic period. This orbit remains within 4574 km of the L_4 point for the 12 periods investigated. Deviations from the mid orbit during this time is less than 381 km. Author

N67-18633* National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
LUNAR RESOURCES: THEIR VALUE IN LUNAR AND PLANETARY EXPLORATION
Paul D. Lowman, Jr. Sep. 1966 33 p refs
(NASA-TM-X-55673; X-641-66-443) CFSTI: $3.00 CSCL 22A

The nature and utilization of lunar resources as a means of increasing the economy of manned lunar and planetary exploration, is reviewed. The chief lunar energy source is solar radiation; in addition, geothermal steam, if available, would be valuable. Material resources, for life support, structural purposes, and rocket fuel, which can be expected to exist in the moon include oxygen, iron, magnesium, silicon, and other elements found in meteorites. Extraction of these resources includes mining, handling, and processing. Processing for elements such as oxygen and hydrogen will probably be done by thermal dissociation, electrolytic reduction, or chemical reduction. Economic analysis of lunar resource use is centered chiefly on rocket fuel, which would be the major use for lunar materials, and secondarily on life support. Parametric studies based on estimates of demand, transportation factors and manufacturing cost, indicate that the cost of interplanetary missions can be reduced by factors of 4 to 10 with the use of lunar and planetary resources. Author

N67-18639*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
CLASSIFICATION OF LUNAR SATELLITE ORBITS
Theodore L. Felsentreger Aug. 1966 32 p refs
(NASA-TM-X-55670; X-547-66-404) CFSTI: HC $3.00/MF $0.65 CSCL 22C

A classification is presented of lunar satellite orbits perturbed by the earth and by the non-sphericity of the lunar gravitational field (the second zonal harmonic only). The orbits are arranged in three categories—those in which the argument of perilune circulates, those in which it librates about some odd multiple value of $\pi/2$, and a class of transition orbits which belong to neither of the other two classes. The discussion is kept as general as possible by holding the semi-major axis arbitrary. In addition, two examples are presented to clarify the analysis. Graphs for these cases show the permissible ranges of the two parameters involved (integrals of the satellite motion) for the orbit classes. Author

N67-18650*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
OBSERVATIONS OF THE EARTH'S MAGNETIC TAIL AND NEUTRAL SHEET AT 510,000 KM BY EXPLORER 33
N. F. Ness, K. W. Behannon, S. C. Cantarano, and C. S. Scearce 7 Nov. 1966 22 p refs
(NASA-TM-X-55691; X-612-66-529) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Preliminary results of a study of the geomagnetic tail from data obtained by magnetic field observations of Explorer 33 over a period of 55 days were reported. The satellite employed a triaxial fluxgate sensor to eliminate spurious contributions to the measurements from spacecraft generated magnetic fields; three component measurements and digitization were performed by the instrument in 10 milliseconds. A sequence magnetic field was computed by linearly averaging the separate orthogonal components in a non-rotating payload coordinate system. It was concluded that the magnetic tail of the earth extends well beyond the orbit of the Moon; its general characteristics, away from the neutral sheet and through the neutral sheet, were the same as previously observed by the IMP-1 satellite. G.G.

N67-18652* National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York
THE UPPER ATMOSPHERE OF MARS
S. H. Gross (Airborne Instr. Lab.), W. E. McGovern (New York Univ.), and S. I. Rasool [1966] 16 p refs Submitted for publication (NASA-TM-X-57327) CFSTI: $3.00 CSCL 03B

The thermal structure of the upper atmosphere of Mars has been theoretically investigated. It is found that the exospheric temperature, for a pure CO_2 model atmosphere, lies between 400–700°K. The origin of the Martian atmosphere is discussed in the light of these results. Author

N67-18653* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
SATELLITE MEASUREMENTS OF MAGNETIC FIELDS IN SPACE
Norman F. Ness Nov. 1965 25 p refs Submitted for publication (NASA-TM-X-57116) CFSTI: $3.00 CSCL 03B

Direct measurements of the physical properties of cislunar space by satellites and space probes confirmed the existence of solar wind and the continual confinement of the geomagnetic field, as well as the development of an extended magnetic tail of the earth. On the nightside of the earth the terrestrial field trails out in a highly distorted fashion at least halfway to the moon. The boundary area observed between the geomagnetic field and the undisturbed interplanetary medium was tentatively identified as a collisionless magnetohydrodynamic shock wave. Gross characteristics of the distorted magnetic field, its boundary layer, and the recently observed detached bow shock wave were discussed in detail. G.G.

N67-18657# Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.
AEROSPACE THERMODYNAMIC PROPERTIES EXPECTED ABOVE CAPE KENNEDY FOR THE 1966–1977 PERIOD
P. E. Wasko and C. M. Michaux Nov. 1966 47 p refs (DAC-59171)

The Earth's aerospace thermodynamic properties from 100 to 100,000 km altitude above Cape Kennedy, Florida, are determined from theoretical and empirical relations fitting rocket and satellite observations. A forecast of these properties is made for the minimum, medium, and maximum activity phases of the 11-year solar cycles in the period from July 1966 to July 1977 by the use of the solar 10.7-cm flux index and the thermopause temperature correlation. Median values for diurnal minimum, diurnal mean, and diurnal maximum densities and pressures, as well as extreme values corresponding to expected extreme solar activities, are prepared for aerospace engineering studies and applications. A comparison is made of recently observed values with the predicted ones. Author

N67-18663 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
RECENT PROGRESS OF THE THEORY OF ORBIT TRANSFER [RECENTS PROGRES DE LA THEORIE DU TRANSFERT D'ORBITE]
Marchal Marec *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 6 (See N67-18661 08-34) CFSTI: $3.00

For application to space exploration missions, the most economical procedure of rendezvous and transfer orbit maneuvers is highlighted in this conference discussion. In the study of transfer or rendezvous between orbits of non-specified magnitude, results are briefly listed for: transfer between a parabolic and any other type orbit, elliptic-hyperbolic, or hyperbolic-elliptic transfer, transfer between coaxial, non-coplanar ellipses, and transfer between coplanar ellipses. Also merely outlined are propulsion systems at a given ejection speed and limited thrust in transfer or close rendezvous orbits during a fixed, limited time period. Transl. by R.Ll.

N67-18664 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
MODERN OPTIMIZATION TECHNIQUES APPLIED TO THE PROBLEM OF HIGH SPEED GLIDE TRAJECTORY [TECHNIQUES MODERNES D'OPTIMISATION APPLIQUEES AU PROBLEME DE LA TRAJECTOIRE PLANEE A GRANDE VITESSE]
J. Fave *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 7–8 (See N67-18661 08-34) CFSTI: $3.00

An hypothesis is presented on the optimization of the trajectory of an aerodynamic orbital glider in a given transfer orbit. An iteration process and a gradient method are used in the determination of the incidence and rolling of the glider. Calculations made on an IBM 704 computer are briefly considered for other possible applications of the method, and some difficulties of application analyzed. Transl. by R.Ll.

N67-18711*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
THE LIBRATION OF MERCURY
Han-Shou Liu [1965] 9 p ref Submitted for Publication (NASA-TM-X-57295) CFSTI: HC $3.00/MF $0.65 CSCL 03C

Equations of rotation for the planet Mercury are integrated on an IBM 7090 computer by applying the Runge-Kutta integration algorithm, and numerical solutions for the librational motion are thereby presented. The computer program performs the necessary algorithms for successively updating expansions of a differential equation for planetary rotation, and only insignificant terms are truncated. Perturbations of the two-thirds orbital period rotation of Mercury are calculated to within one-tenth of an arc second. M.W.R.

N67-18726*# National Aeronautics and Space Administration, Washington, D. C.
SATELLITE GEODESY
J. K. Gleim and Nancy G. Roman *In its* Significant Achievements in Space Appl., 1965 1966 p 11–14 refs (See N67-18724 08-31) GPO: HC $0.45; CFSTI: MF $0.65

The orbital parameters and working characteristics of the beacon carrying Explorer XXVII satellite are discussed. This satellite has ionospheric beacons, Doppler beacons, and a telemetry and tracking transmitter. It also carries corner mirrors on its forward face that reflect laser beams transmitted from ground stations. Orbital determinations and data residuals from the Doppler tracking of five Explorer satellites were evaluated to obtain values for the zonal harmonics of the Earth's gravitational field and to compute a shape of the geoid. A strong relation between the harmonic coefficients of low degree for the geoid and those for the topography was established. G.G.

N67-18730*# National Aeronautics and Space Administration, Washington, D. C.
ASTRONOMY IN SPACE
Homer E. Newell, Henry J. Smith, Nancy G. Roman, and George E. Mueller 1967 67 p refs (NASA-SP-127) GPO: HC $0.45; CFSTI: MF $0.65 CSCL 03A

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3. STELLAR AND GALACTIC ASTRONOMY N. G. Roman p 27–48 refs (See N67-18733 08-30)
4. EXPANDING VISTAS IN ASTRONOMY G. E. Mueller p 49–67 refs (See N67-18734 08-30)

N67-18731*# National Aeronautics and Space Administration, Washington, D. C.
SPACE ASTRONOMY PROGRAM OF THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Homer E. Newell *In its* Astronomy in Space 1967 p 1–8 (See N67-18730 08-30) GPO: HC $0.45 CFSTI: MF $0.65

The past history and current expenditures for the United States space science and applications program are briefly outlined with emphasis on astronomical research. Various contributions of the space program to astronomy cumulated in the development of the orbiting solar observatory and an advanced solar satellite with rougly ten times the pointing and data capacity of OSO. Also described is the Apollo telescope mount to be used by an astronaut in a manned space flight mission. G.G.

N67-18732*# National Aeronautics and Space Administration, Washington, D. C.
SOLAR ASTRONOMY
Henry J. Smith *In its* Astronomy in Space 1967 p 9–25 (See N67-18730 08-30) GPO: HC $0.45 CFSTI: MF $0.65

Discussed is NASA's space flight program in solar astronomy by considering observations in the following areas: (1) small vehicles; (2) the orbiting solar observatory satellite series; and (3) the future flight program, including the advanced OSO and the Apollo telescope mount. This program encompasses the use of balloons, aircraft, sounding rockets, unmanned satellites, and manned space flights. The first five OSO satellites experiments placed emphasis upon spectrographic and image-forming spectroheliographic observations, as well as on monitoring the temporal variations of the whole-Sun brightness in ultra violet, X-rays, and gamma rays; also depicted are additional geophysical experiments. G.G.

N67-18733*# National Aeronautics and Space Administration, Washington, D. C.
STELLAR AND GALACTIC ASTRONOMY
Nancy G. Roman *In its* Astronomy in Space 1967 p 27–48 refs (See N67-18730 08-30) GPO: HC $0.45; CFSTI: MF $0.65

A brief outline of the NASA space astronomy program is presented and descriptions of the various satellite experiment packages for the orbiting astronomical observatories are given. Described are the ultraviolet experiment package; a 36-inch diameter telescope for spectrophotometry of faint stars; and a 32-inch spectrometer to observe brighter X-ray sources with high resolution at 3 to 9 Å, 8 to 18 Å, and 44 to 60 Å. Most of the results in space astronomy to date are obtained through the use of sounding rockets; significant progress has been made in the measurement of the spectrum of the cosmic background at frequencies between 1 and 5 MHz. G.G.

N67-18734*# National Aeronautics and Space Administration, Washington, D. C.
EXPANDING VISTAS IN ASTRONOMY
George E. Mueller *In its* Astronomy in Space 1967 p 49–67 refs (See N67-18730 08-30) GPO: HC $0.45; CFSTI: MF $0.65

In this paper, we have surveyed the expanding vistas of astronomy made possible by space flight, the status of the development of future capabilities, and some of the ways these capabilities might be employed. In the discussion of possible future steps, only schedules for events of the near future are discussed. Discussion of costs has been totally omitted. The competition is keen for the placing of experiments aboard our vehicles, both manned and unmanned, as well as for the time of the astronauts. Many opportunities are now unfolding to learn answers to such fundamental questions as the age and size of the universe itself; but the degree to which these opportunities are seized will depend on the wishes of the astronomical community. Author

N67-18737*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
SHORT PERIOD LUNAR AND SOLAR PERTURBATIONS FOR ARTIFICIAL SATELLITES
David Fisher and James P. Murphy Oct. 1966 56 p refs (NASA-TM-X-55683; X-547-66-483) CFSTI: HC $3.00/MF $0.65 CSCL 22C

Two sets of expressions for the short period perturbations due to lunar and solar gravitational forces in the orbital elements of artificial satellites are derived. The first set of expressions applies to the case of small eccentricity while the second set is applicable to orbits of arbitrary eccentricity. The results are tabulated in a form suitable for programming on high speed computers. Author

N67-18741*# Volt Technical Corp., Washington, D. C.
INVESTIGATION OF X-RAY EMISSION OF THE MOON WITH THE HELP OF "AMS LUNA-10" [ISLEDOVANIYA RENTGENOVSKOGO IZLUCHENIYA LUNY S POMOSHCH'YU SPUTNIKA LUNY "LUNA-10"]
S. L. Mandel'shtam, I. P. Tindo, and V. I. Karev 26 Jan. 1967 14 p refs Transl. into ENGLISH from Kosmich. Issled. Izd. "Nauka", (Moscow), v. 4, no. 6, 1966 p 827–837
(Contract NAS5-12487)
(NASA-CR-82097; ST-RAD-ACH-LPS-10-556) CFSTI: HC $3.00 CSCL 03B

The calculation is presented of fluorescent characteristics of silicium, aluminum, and magnesium lines in the composition of the surface layer of lunar rocks excited by X-ray radiation of the sun. Description is given of the apparatus designed for the experimental detection of moon's X-ray emission and installed aboard AMS Luna-10. The results of measurements are brought forth, in the course of which was determined the cosmic background level in the vicinity of the moon, detecting at the same time the electrons with energy greater than 40 kev of the earth's magnetosphere tail. The preliminary data on the registration of X-ray radiation are also given. Author

N67-18744*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
LUNAR OCCULTATION AND PROVISIONAL IDENTIFICATION OF MSH 21–23
Larry W. Brown Aug. 1966 13 p refs Ionospheric Phys. Preprint Series
(NASA-TM-X-55666; X-615-66-348) CFSTI: HC $3.00/MF $0.65 CSCL 03A

The radio source MSH 21–23 was observed by means of a lunar occultation on June 18, 1965. The occultation has provided a possible optical counterpart to the radio source, as well as position and diameter measurements. The observation was made with a switched type receiver employing gain modulation and an 85 foot parabolic antenna tracking the center of the moon. The receiving frequency was 403 Mc/s with an intermediate frequency of 30 Mc/s, bandwidth of 5.0 Mc/s and RC integration time of 3 seconds. Digitized records of the disappearance and reappearance of the source are shown. In addition the reappearance phase was observed at 137 Mc/s with a bandwidth of 2.5 Mc/s. The data has been restored and a gaussian curve fitted to the resulting brightness distribution. Analysis of the fit provides the best values for the position of the intensity peak and the source diameter along the scan. The diameter and position angles are tabulated. Author

N67-18746*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
AN ORBITAL ANALYSIS TECHNIQUE FOR SHARPLY VARYING GEOPHYSICAL PHENOMENA
Larry R. Muenz Aug. 1966 16 p refs
(NASA-TM-X-55672; X-621-66-441) CFSTI: HC $3.00/MF $0.65 CSCL 22C

A technique has been developed for increasing the time resolution of high accuracy satellite orbital parameters. The technique may be used to allow the association of orbital parameters with the precise time of experiment data sampling rather than with the uniformly spaced times normally available. Thus, geophysical phenomena having high spatial gradients may be resolved more clearly with respect to latitude, longitude, and altitude. Using this method an elliptical orbit is adjusted to one point on the non-elliptical, perturbed orbit allowing the extrapolation of orbital parameters to times near the initial point. The equations for this extrapolation follow directly from a consideration of the sub-satellite path. By virtue of its intended application, the method may be interpreted as an interpolation, with no sacrifice in accuracy, between successive orbital data samples. An accuracy of .01 degree is obtained for latitude and longitude in regions where these parameters vary most rapidly and an accuracy of 1 kilometer is obtained for altitude (all after an extrapolation time of 3 minutes). Author

N67-18755*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
EFFECTS OF THE SOLAR AND LUNAR TIDES ON THE MOTION OF AN ARTIFICIAL EARTH SATELLITE
David Fisher and Theodore L. Felsentreger Nov. 1966 14 p refs
(NASA-TM-X-55696; X-547-66-560) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The series describing the perturbations in the orbital elements of an artificial satellite due to solar and lunar tides are presented in a form convenient for computation. In addition, the potential function and its gradient are given in terms of rectangular coordinates. Author

N67-18763*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A REPRESENTATION OF THE PERIGEE MOTION OF A SATELLITE AS A FUNCTION OF LOCAL TIME
Robert A. Langel Feb. 1967 12 p refs
(NASA-TM-X-55703; X-612-67-34) CFSTI: HC $3.00/MF $0.65 CSCL 22C

A procedure was developed for a graphic display of one specialized feature of a satellite orbit—the relationship of the perigee of the orbit to latitude and to local time. From this plot it is a very simple matter to see exactly when in a satellite lifetime it will encounter a particular sunlight configuration. At what latitude the satellite approaches closest to the earth can also be readily seen. Obvious applications are predictions of eclipse times and periods of maximum drag. From a geophysical viewpoint, one may predict when satellite data should be examined for effects which are local time and/or latitude dependent. Author

N67-18765*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
DIFFERENTIAL CORRECTIONS APPLIED TO VINTI'S ACCURATE REFERENCE SATELLITE ORBIT WITH INCLUSION OF THE THIRD ZONAL HARMONIC
Harvey Walden and Stan Watson Oct. 1966 52 p refs
(NASA-TM-X-55699; X-543-66-544) CFSTI: HC $3.00/MF $0.65 CSCL 22C

A differential method of orbit improvement utilizing observational data is presented for Vinti's spheroidal solution of the dynamical problem of unretarded artificial satellite motion about an oblate planet, recently modified so as to permit the exact inclusion of the effects of the third zonal harmonic term of the planet's gravitational potential field. The first-order Taylor's series expansion used for the equations of condition is fitted to observational values by an iterated least-squares process, producing successively smaller corrections to the orbital elements. A mean set of elements, conditioned by the observations, results for use in orbital predictions for intermediate time points or for later epochs. The differential coefficients in the conditional equations, applicable to any type of observational data, are derived analytically from the equations of the accurate reference orbit. The method of differential correction may be used for orbits of all inclinations, including equatorial and polar, and both a first-order and a lengthier, but more exact, second-order treatment for the periodic variables are given. Author

N67-18771*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
JUPITER'S MAGNETOSPHERE
J. A. Gledhill Feb. 1967 11 p refs
(NASA-TM-X-55704; X-615-67-47) CFSTI: HC $3.00/MF $0.65 CSCL 03B

A magnetospheric model of Jupiter is presented which shows the maximum plasma densities that can co-rotate with the planet. First an estimate is made of the maximum number density of the plasma in the equatorial plane by equating the magnetic and rotational kinetic energy densities. Then a method is used to calculate the distribution of plasma along the line of force. It is shown that the effect of the centrifugal force is to confine the plasma to a discus-like region about the plane at 7° to the equatorial plane. Details and refinements of these calculations are not included. S.P.

N67-18776*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
A FEW FURTHER RESULTS ON UNPERTURBED ORBITS AND ACCURACY RESULTS ON PERTURBED ORBITS FOR A LUNAR ORBITER
17 Feb. 1966 30 p ref
(Contract NAS7-100)
(NASA-CR-82159; JPL-TM-312-620, Append. 1) CFSTI: HC $3.00/MF $0.65 CSCL 22C

Accuracy results for perturbed Lunar Orbiter trajectories are presented as well as data on the unperturbed Kepler orbits. These results are based on a study of the computer program SPACE for Lunar Orbiter trajectories. The trajectories used no perturbations and the injection conditions were the osculating values of the S110 mission as it entered the final (photographic) orbit. Further results on the unperturbed or two-body orbits are examined. The accuracy results for trajectories that include the effects of perturbations, and the effect of the variational equations running time are discussed. It is concluded that there exists the same order of accuracy in the simulation of perturbed lunar orbits as in unperturbed lunar orbits. S.P.

N67-18911* Texaco Experiment, Inc., Richmond, Va.
LUNAR GEOPHYSICAL SURFACE AND SUBSURFACE PROBES FOR APOLLO APPLICATIONS PROGRAM. VOLUME I: DETAILED TECHNICAL REPORT
R. H. Clinard, Jr. 27 May 1966 444 p refs
(Contract NAS8-20085)
(NASA-CR-82157; EXP-462, Vol. I; TP-277, Vol. I) CFSTI: $3.00 CSCL 22B

A study has been carried out to determine the optimum integrated instrument probes to be used for manned lunar exploration with the Apollo Applications Program. A lunar probes system is recommended consisting of: an optimum subsurface probe, a subsurface neutron–gamma probe, a subsurface television probe, and integrated surface probe, a supporting electronics package, a deployment and cable assembly, and an acoustic source holder. This system is described in detail with the justifications, instruments characteristics, and operations requirement of the selected experiments given. Information is also included on experiments considered in the study, which do not appear in the recommended system. Non-functional mockup hardware of the recommended probes was constructed for use in system integration studies and time-and-motion-study testing. Author

N67-18944*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
OPTIMUM TRAJECTORIES IN A CENTRAL FORCE FIELD
Carlos R. Cavoti Jan. 1967 26 p refs
(Contract NAS9-5550)
(NASA-CR-65595) CFSTI: HC $3.00/MF $0.65 CSCL 22C

Necessary conditions for a strong relative minimum are derived within the framework of a generalized Mayer formulation. Such necessary conditions apply to a variety of optimal problems which are obtained as particular cases of the general form here considered. The trajectories involved may imply an orbital transfer, a lunar landing, etc. The existence of intermediate-thrust sub-arcs is analyzed for a minimum fuel consumption problem using the general conditions derived. The analysis shows that no intermediate-thrust sub-arc may form part of the extremal in such case. The technique applied in the demonstration appears to be applicable to investigate the existence of intermediate-thrust sub-arcs in other variational problems which derive from the general form considered. Author

N67-18956*# Volt Technical Corp., Washington, D. C.
MEASUREMENTS OF MOON'S RADIATION FLUXES IN THE INFRARED AND IN THE VISIBLE REGIONS OF THE SPECTRUM ON THE AMS LUNA-10 [IZEMERENIYA POTOKOV IZLUCHENIYA LUNY V INFRAKRASNOY I VIDIMOY OBLASTYAKH SPEKTRA NA CPUTNIKE "LUNA-10"]
A. I. Lebedinskiy, A. A. Lozhnikov, and V. I. Tulupov 23 Dec. 1966 7 p refs Transl. into ENGLISH from Kosmich. Issled. (Moscow), v. 4, no. 6, 1966 p 838–841
(Contract NAS5-12487)
(NASA-CR-82438; ST-LPS-RAD-10549) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Measurements of integral radiation flux of the moon in the infrared have been carried out on the artificial satellite of the moon "LUNA-10". The instrumentation consisted of radiation receivers constituting flat plates of 15 by 30 mm dimensions, disposed in series. One of the receivers was covered with enamel, absorbing well the infrared radiation (85–95 percent) and reflecting 70 to 75 percent of visible light. The other receiver was covered with gold foil. Obtained simultaneously, the data of both receivers allow the determination of the thermal radiation flux of the moon. Author

N67-18959*# Volt Technical Corp., Washington, D. C.
INVESTIGATION OF THE MAGNETIC FIELD FROM THE AMS LUNA-10 [ISSLEDOVANIYE MAGNITNOGO POLYA SO SPUTNIKA "LUNA-10"]
L. N. Zhuzgov, Sh. Sh. Dolginov, and E. G. Yeroshenko 10 Jan. 1967 25 p refs Transl. into ENGLISH from Kosmich. Issled. (Moscow), v. 4, no. 6, 1966 p 880–899
(Contract NAS5-12487)
(NASA-CR-82435; ST-PF-LPS-10552) CFSTI: HC $3.00/MF $0.65 CSCL 03B

A report is given on the observations in the vicinity of the Moon of a structurewise regular magnetic field, of which the intensity during observation time varied within the limits from 24 to 40 γ in accord with the variation of the magnetic activity index on the Earth's surface. The error in the absolute value of the scalar magnitude of the field is estimated by the quantity of $\pm 10\gamma$. Comparison between the measured field values in the pericenter and apocenter regions and the estimate of possible field distortions by solar wind lead to the conclusion about the absence near the Moon of a field of dipole nature. The question is discussed whether the observed field may be identified with the interplanetary field of solar origin, either deformed or trapped by the Moon and having finite conductivity and penetrability. Comparison of measurements during fullmoon and newmoon periods failed to make directly apparent the extension of the Earth's magnetic field on the night side to distances of 60 Earth's radii. Author

N67-18973*# Brown Engineering Co., Inc., Huntsville, Ala. Research Labs.
DIRECTIONAL CHARACTERISTICS OF LUNAR THERMAL EMISSION
C. G. Montgomery, J. M. Saari, R. W. Shorthill (Boeing Sci. Res. Labs.), and N. F. Six, Jr. Aug. 1966 97 p refs Prepared in Cooperation with Boeing Sci. Res. Labs.
(Contract NAS8-20166)
(NASA-CR-82402; R-213; D1-82-0568) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Preliminary studies of the directional characteristics of lunar thermal emission were completed using existing infrared lunation data. Brightness temperatures were obtained at every 10° interval of a thermal latitude and longitude grid system where the subsolar point was defined as the thermal north pole, the antisolar point as the thermal south pole, and the thermal prime meridian as passing through the apparent disk center. The results are presented in the form of a family of plots of brightness temperature versus thermal coordinates. Comparisons with the Lambert diffuse surface law are made. Author

N67-18989*# Maryland Univ., College Park. Dept. of Physics and Astronomy.
NO TITLE Final Report, Apr. 1–Nov. 30, 1966
W. C. Erickson 30 Nov. 1966 7 p
(Grant NsG-615)
(NASA-CR-82481) CFSTI: HC $3.00/MF $0.65 CSCL 03A

Work accomplished on programs involving solar and planetary observations with a decametric array, the construction and operation of an array of log periodic antennas for solar observations in the 20 to 60 MHz region, and the installation and operation of a Jupiter monitoring station is reported. Results of a series of interplanetary scintillation observations indicate that these scintillations are caused by inhomogeneities in the solar wind which produce a diffraction pattern in the radio radiation falling on earth. The scintillations are produced only by radio sources of small angular size and from a useful tool for studies of small angular diameter sources and the solar wind. A.G.O.

N67-19022*# National Aeronautics and Space Administration, Washington, D. C.
SIGNIFICANT ACHIEVEMENTS IN SPACE SCIENCE, 1965
Homer E. Newell 1967 222 p refs
(NASA-SP-138) GPO: HC $1.00; CFSTI: MF $0.65 CSCL 03B

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2. IONOSPHERES AND RADIO PHYSICS E. R. Schmerling p 17–30 refs (See N67-19024 08-13)

3. PARTICLES AND FIELDS A. W. Schardt and A. G. Opp p 31–88 refs (See N67-19025 08-29)

4. PLANETARY ATMOSPHERES R. Horowitz, R. F. Fellows, and H. Hipsher p 89–111 refs (See N67-19026 08-30)

5. PLANETOLOGY M. W. Molloy and U. Liddel p 113–195 refs (See N67-19027 08-30)

6. SOLAR PHYSICS P. J. Dickerman (IIT Res. Inst.) and H. J. Smith p 197–218 refs (See N67-19028 08-29)

N67-19023*# National Aeronautics and Space Administration, Washington, D. C.
SPACE ASTRONOMY
A. G. W. Cameron, J. K. Gleim, and F. T. Haddock (Mich. Univ.) *In its* Significant Achievements in Space Sci., 1965 1967 p 1–15 refs (See N67-19022 08-30) GPO: HC $1.00; CFSTI: MF $0.65

Principal efforts in the fields of X-ray, ultraviolet, and radio astronomy are reviewed. Both rockets and balloons were used to

survey the sky to detect X-ray sources and then locate them precisely so that they could be identified with known astronomical objects. The approximate gamma-ray flux upper limits are tabulated for possible discrete sources. The ultraviolet regions were studied by broadband spectrophotometry and photometry to obtain statistical data needed to understand characteristics of many types of stars. The Orbiting Astronomical Observatory is described, and spectrophotometric data for several stars are discussed. In radio astronomy the principal space efforts were to develop instrumentation to be carried aloft by a satellite. Launching of the OGO II and Alouette II is mentioned. S.P.

N67-19026*# National Aeronautics and Space Administration, Washington, D. C.
PLANETARY ATMOSPHERES
Richard Horowitz, Robert F. Fellows, and Harold Hipsher *In its* Significant Achievements in Space Sci., 1965 1967 p 89–111 refs (See N67-19022 08-30) GPO: HC $1.00; CFSTI: MF $0.65

A description of the diurnal density bulge in the Earth's atmosphere involving composition, temperature, and airglow is presented. Tabulated are the number densities of the neutral atmospheric constituents. Experiments aboard Explorer XVII represent the first attempt toward measuring on a global scale the composition of the neutral atmosphere and its temporal variations. The thermosphere probe temperature measurements, based on the scale height of the molecular–nitrogen density obtained under different atmospheric conditions, are summarized. Sodium release during rocket flights has revealed that strong shear zones exist at altitudes from 70 to 120 kilometers. A wavelike structure has been detected in some neutral temperature profiles, possibly revealing the presence of gravity waves. Simultaneous measurements of midlatitude night airglow and particle precipitation indicate that the midlatitude 5577 Å night airglow is not excited by charged particle bombardment as it is in auroras. Spectroscopic measurements made during the recent Mars opposition yield values between 7 and 13 millibars for the surface pressure. Radio measurements of Venus indicate a surface temperature of approximately 600°K and a surface pressure ranging from ≈10 to ≈200 Earth atmospheres. S.P.

N67-19027*# National Aeronautics and Space Administration, Washington, D. C.
PLANETOLOGY
M. W. Molloy and Urner Liddel *In its* Significant Achievements in Space Sci., 1965 1967 p 113–195 refs (See N67-19022 08-30) GPO: HC $1.00; CFSTI: MF $0.65

Achievements in planetology during 1965 made by space probes, ground-based observations, and theoretical studies are described. Mariner IV, Ranger VIII and IX, Gemini missions IV to VII, and Soviet spacecraft were instruments for the most significant accomplishments. With respect to Earth-based observations, the moon was studied by infrared mapping, high-resolution radar, cartographic and photogeologic mapping, and lunar landing site investigation. Through optical, radio, and radar astronomy major mountain chains on Venus were revealed and the behavior of Jupiter was examined. Meteorite research was achieved through electron microprobe studies, and tektite investigations concentrated on the supposed sources of tektites by means of structural and microchemical investigations. Terrestrial analogs of lunar and planetary surface features were studied by regional mapping of major geologic structures of volcanic and possible meteorite impact origin, by hypervelocity impact investigations, and by detailed mineralogic studies of shock effects. S.P.

N67-19034*# Northwestern Univ., Evanston, Ill. Dearborn Observatory.
ROTATING EMISSION RING IN BINARY SYSTEMS
Su-Shu Huang 4 Oct. 1966 25 p refs
(Grant NGR-14-007-041)
(NASA-CR-82476) CFSTI: HC $3.00/MF $0.65 CSCL 03C

The periodic orbits around the more massive component in the restricted three-body problem have been taken as representing quantitatively the rotating gaseous rings discovered through their emission lines in many eclipsing binaries. The periodic orbits have been obtained first through a series expansion and further improved by the successive approximation. Thus, a theoretical relation, in a tabulated form, has been obtained between the velocity of the emission ring and its distance from the more massive component for each of six values of the mass ratio of the two component stars. By using this theoretical relation, the masses of two components in the binary system may be determined by observing the emission ring during eclipse. As an illustration the masses of the two components of RY Gem have been found. Applying the same idea of the periodic orbits, we have also examined the nature of non-synchronous rotation in U Cep and RZ Sct. Author

N67-19069# European Space Research Organization, Paris (France).
ESRO SCIENTIFIC ROCKET PROGRAM
Dec. 1965 246 p
(ESRO-SR-5) CFSTI: HC $3.00/MF $0.65

Rocket proposals based on use of Centaur, Skylark, and Beller rockets, and for experiments requiring higher altitudes (in the 300 to 500 km range) Dragon rockets, are contained in this program report. Each sounding rocket proposal mentions the research organization, group leader, scientific project manager, and the title of the experiment; and includes a description of the experiment, the techniques, telemetry requirements, and historical notes. The ESRO sounding rocket projects carried out in 1964 and 1965 are also listed. ESRO

N67-19079*# Stanford Univ., Calif. Inst. for Plasma Research.
A PLASMA MODEL OF QUASARS AND RADIO GALAXIES
P. A. Sturrock [1966] 41 p refs Lectures Presented at Intern. School of Phys. "Enrico Fermi," 29th Course, Varenna, Italy, Jul. 1966
(Grant NsG-703; Contracts AF 49(638)-1321; N00014-67-A-0112-006)
(NASA-CR-82503; SUIPR-99) CFSTI: HC $3.00/MF $0.65

Events associated with quasi-stellar objects (quasars) are treated as plasma phenomena in a series of lectures dealing with high energy radiation. A summary of these lectures deals with a model of what these quasars are and how they are formed. It is noted that the explosions of quasars and the explosions in certain galaxies that are strong radio emitters are probably quite similar, and that quasar explosions are unlike supernova-like explosions. Since the observed optical and radio fluctuations indicate that quasars are nonstatic, the influence of plasma turbulence on stability properties is discussed. An equivalent procedure using the principle of virtual work is used to investigate the equilibrium state and nucleus stability, and the use of a proposed model to determine the properties of quasar nuclei is discussed. M.W.R.

N67-19081* Philco Corp., Palo Alto, Calif. WDL Div.
FEASIBILITY STUDY ON THRUST-AUGMENTED SWING-BY, INTERPLANETARY MISSIONS Interim Report
E. W. Onstead 15 Sep. 1966 114 p refs
(Contract NAS8-20358)
(NASA-CR-82518;WDL-TR3059) CFSTI: $3.00 CSCL 22A

The primary objective of this study is to determine the effect of thrust-augmented maneuvers on total mission time, mission characteristic velocity, Earth entry velocity, Mars departure velocity, and payload on orbit at Mars. In order to obtain the parametric data required for the analysis of the problem, a Fortran IV program suitable for rapid analysis of swing-by missions was written and its output was combined with the SC-4020 automatic plotter. The

program is constructed to utilize flight time from the launch to the target body as the independent parameter and flight time from the launch to the intermediate body as a secondary parameter. The program is capable of producing either parametric data or data associated with the minimization of zero search of a given function of flight time from launch to target body. The results of a parametric analysis with data generated for a Mars launch opportunity for March 2, 1978 are presented. K.W.

N67-19105* Innsbruck Univ. (Austria). Inst. of Theoretical Physics.
THE FORCES AND TORQUES ACTING ON SATELLITES AND THE DYNAMICAL EQUATIONS DESCRIBING THEIR MOTION ABOUT A FIXED POINT OF THE BODY
A. Schett and J. Weil [1967] 37 p refs
(Grant NGR-52-046-001)
(NASA-CR-82666; SR-13) CFSTI: $3.00 CSCL 22A

A survey of forces and torques acting on a satellite and dynamical equations describing the attitude of a satellite are presented. The following principal forces acting on a satellite are discussed: the gravitational forces which are caused by a spherically symmetric potential field, perturbational forces corresponding to an asymmetry of the gravitational field caused by oblateness and inhomogeneity of the earth, drag forces due to vehicle movement in a rarified gas rather than in vacuum, force due to radiation pressure, gravitational forces due to the action of the sun and the moon, magnetic force, and the force due to casual effects. Analytic expression for the following torques are derived: gravitational torque, torque due to gravitational asymmetry, drag torque, torque caused by radiation, torque due to the gravitation of sun and moon, magnetic torque, and torque due to casual effects as collisions with meteorites. A survey of papers dealing with the attitude of a satellite and with gravity gradient stabilization is included. S.C.W.

N67-19114* Northwestern Univ., Evanston, Ill. Dearborn Observatory.
ROTATIONAL BEHAVIOR OF THE STARS AND ITS PLAUSIBLE CONSEQUENCES CONCERNING FORMATION OF PLANETARY SYSTEM. II
Su-Shu Huang [1966] 26 p refs
(Grant NGR-14-007-041)
(NASA-CR-82656) CFSTI: $3.00 CSCL 03C

Following the view taken in a previous paper that the statistical behavior of the observed rotational velocities of stars depends upon the braking mechanism, several statistical models based on the truncated Maxwellian distributions of original stellar angular moments as well as on different braking processes, were studied. Observational results indicate that the rate of decrease of angular momentum of a star at any moment must be proportional to the first and/or higher powers of the angular momentum itself. No constant term should occur in the braking equation. Arguments have been advanced to show that the braking of stellar rotation leads to formation of planetary systems. Therefore the observed statistical property of early-type main-sequence stars that rotate rapidly may be used as giving an estimate for the frequency distribution of planetary systems around the late-type main-sequence stars that do not rotate significantly. Author

N67-19121*# Grumman Aircraft Engineering Corp., Bethpage, N. Y.
MECHANICAL, OPTICAL, THERMAL AND ELECTRICAL PROPERTIES OF THE SURVEYOR 1 LANDING SITE
John D. Halajian Nov. 1966 37 p refs Presented at the Am. Astron. Sci. Meeting, Huntington Beach, Calif., 17 Sep. 1966
(NASA-CR-82458; AS-424-4) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Surveyor 1 data are evaluated with particular emphasis on the soil mechanics of the landing site. A downward revision of the bulk density of the lunar surface material from a previously suggested value of 1.5 g/cm^3 to about 1 g/cm^3 is proposed on the basis of mechanical, thermal, photometric and dielectric evidence. The revision indicates an underdense, partially consolidated material that can be approximated on earth by snow or semi-welded tuffs. The principles of conventional soil mechanics do not readily apply to the study of such materials. Further analysis of Surveyor 1 data and, particularly, coordination between astronomical and on-site measurements of the lunar surface are suggested to refine these estimates and increase the usefulness of future Surveyors. Author

N67-19138*# California Univ., Berkeley. Space Science Lab.
SOLAR SOURCE OF THE INTERPLANETARY SECTOR STRUCTURE
John M. Wilcox and Norman F. Ness (NASA, Goddard Space Flight Center) 3 Jan. 1967 18 p refs /ts Ser. No. 7, Issue No. 72
(Grant NsG-243; Contract Nonr-3656(26))
(NASA-CR-82443) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The interplanetary sector structure observed by the IMP-1 satellite during three solar rotations in 1963–4 is compared with the photospheric magnetic field structure observed with the solar magnetograph at Mt. Wilson Observatory. The interplanetary sector structure was most prominent on the sun in latitudes between 10°N and 20°N, although the average heliographic latitude of the satellite was 3-1/2°S. A superposed-epoch analysis of the calcium plage structure obtained from the Fraunhofer Institute daily maps of the sun is used to discuss the relation between the structure of the plages and the interplanetary sector structure. A possible explanation for the observations is discussed in terms of a north–south asymmetry in the flow of the solar wind. It is suggested that these observations favor the "equinoctial" hypothesis as compared with the "axial" hypothesis for the explanation of the semiannual maxima in geomagnetic activity. Author

N67-19215# Defence Research Board, Ottawa (Ontario).
SIZE OF LUNAR CRATERS AND THE CHRONOLOGY OF THE MOON
Hitoshi Takeuchi and Hitoshi Mizutani Nov. 1966 5 p refs Transl. into ENGLISH from Kagaku Kogyo (Japan), v. 36, no. 7, 1966 p 392–393
(T-92-J) CFSTI: HC $3.00/MF $0.65

Recent research concerned with determining the relative ages of different lunar terrains using rules modeled on those of terrestrial geology are discussed. Also presented is an argument that attempts to explain why lunar craters are larger in diameter and depth than meteorite craters on the earth. The argument is based on the fact that the moon's gravitational force is one-sixth of that on the earth's surface. R.N.A.

N67-19217# Smithsonian Astrophysical Observatory, Cambridge, Mass.
VARIABLE STARS IN THE SMALL MAGELLANIC CLOUD
Cecilia Payne-Gaposchkin and Sergei Gaposchkin Washington, Smithsonian Inst., 1966 210 p refs /ts Contrib. to Astrophys., Vol. 9
(Grant NSF G-22496)

Results of a systematic study of variable stars discovered at Harvard in the Small Magellanic Cloud are presented. Tabulated are data for about 1300 stars the majority of which (91%) are Cepheids. Results for the Cepheid variables, arranged in order of period are summarized. Successive columns give the HV number, the adopted period in days, its logarithm, maximal and minimal magnitudes corrected for absorption, amplitude in magnitudes, integrated mean magnitude at mean intensity corrected for absorption in magnitudes, interval from minimum to maximum in terms of

period, the skewness, and the adopted correction for absorption. The parameters used for describing the light curve are illustrated. Detailed studies of the periods of 96 Cepheids showed no significant secular change of period for any star of period less than 12 days. The distribution of Cepheids over the face of the Cloud changes with period. Three W Virginis stars are members of the system. The distribution of absorption within the Cloud is similar to that of the H I regions. All but one of the 24 long-period variables are Cloud members, and their distribution is similar to that of Cepheids of period about ten days. Of the 34 eclipsing stars, all but one are members of the Cloud. It is inferred that all stars spend about the same fraction of their life as Cepheids. The duration of the Cepheid state is estimated. The amplitude frequency leads to the conclusion that the pulsations are driven within the Cepheid gas, and are small outside it. Maximal amplitude is probably not the same for all Cepheids. S.C.W.

N67-19245*# Illinois Univ., Urbana. Coordinated Science Lab.
THE EFFECTS OF THE NODAL REGRESSION OF THE ORBIT ON THE GRAVITY PRECESSION OF A GYROSCOPIC SATELLITE
James L. Myers, Jr. Jul. 1966 23 p refs
(Grant NsG-443; Contract DA-28-043-AMC-00073(E))
(NASA-CR-82592; R-309) CFSTI: HC $3.00/MF $0.65 CSCL 22A

A gyroscopic satellite has been proposed for a test of the general theory of relativity in which the gyro "drift" rate to be measured is less than seven seconds of arc per year. The Coordinated Science Laboratory has proposed a simple passive gyroscope which uses sunlight reflected from mirrors to provide optical data to determine the spin axis orientation. The gravity gradient torque acting on the satellite is one of several extraneous disturbances which can cause spurious precession of the gyro spin axis. In this paper, general equations for the precession of a gyro satellite in a regressing orbit are derived. These equations may be used to specify the tolerances for initial spin axis and orbit alignments which enable an accurate measurement of the relativity effect. Author

N67-19351 Royal Observatory, Edinburgh (Scotland).
OBSERVATIONS OF INTERSTELLAR REDDENING. III: RESULTS FOR REGION IN CASSIOPEIA
K. Nandy [1966] 16 p *Its Publ.*, Vol. 5, No. II HMSO: 5s

The wavelength dependence of interstellar extinction has been investigated for a galactic region in the direction of Cassiopeia, from spectrophotometric measurements in the wavelength range extending from 8000Å to 3450Å. The results have been compared with those obtained earlier for regions in Cygnus and Perseus. It is found that in each of these three directions, the dependence on distance and the intrinsic dispersion about the mean reddening curve are less than 3%. The mean extinction curves for each of the three regions show changes in slope near 4300Å, but this change is significantly greater in the case of the Perseus curve than in the curves for Cygnus or Cassiopeia. Those for Cygnus and Cassiopeia, though not identical, are very similar. Author (ESRO)

N67-19356*# Brown Engineering Co., Inc., Huntsville, Ala. Scientific Research Labs.
DETERMINATION OF TRAJECTORY PARAMETERS RELATIVE TO VARIOUS AROD GROUND STATIONS
H. M. Minshew, A. R. Phillips, and H. C. Crews, Jr. Jun. 1963 61 p
(Contract NAS8-2495)
(NASA-CR-82600; R-39) CFSTI: HC $3.00/MF $0.65 CSCL 22C

The slant range, rate of change of slant range, the maximum slant range acceleration, slant range acceleration, elevation angle, maximum rate of change of elevation angle, azimuth angle, maximum rate of change of azimuth angle, aspect or look angle, and maximum rate of change of aspect angle, as measured from six selected AROD (Airborne Range and Orbital Determination) ground stations, are computed and given as a function of vehicle ground range and time from launch from Cape Canaveral for a 105 NM circular orbit trajectory on an initial bearing angle of 105 degrees. For purposes of analyzing vehicle antenna pattern requirements, the missile azimuth and missile elevation angles are computed and presented for each station as a function of time and vehicle ground range from launch. R.U.

N67-19357* Smithsonian Astrophysical Observatory, Cambridge, Mass.
CATALOG OF PRECISELY REDUCED OBSERVATIONS
18 Nov. 1966 166 p refs
(Grant NsG-87-60)
(NASA-CR-82599; SAO Special Rept.-227; P-15) CFSTI: $3.00 CSCL 22A

This astrophysical observatory special report catalogues the positions of artificial satellites obtained by the precise reduction of films taken at Baker-Nunn 12 camera stations. During this six-month period, all precisely reduced observations were checked by determining their residuals from the best obtainable orbits, and found to be without significant errors. The present catalog includes 410 observations of such satellites as: Vanguard 2, Vanguard 3, Echo 1 Rocket Body, Explorer 9, Transit 4A, Injun, Midas 4, Telstar 1, and A15 Relay. R.U.

N67-19358* Smithsonian Astrophysical Observatory, Cambridge, Mass.
SATELLITE ORBITAL DATA
Beatrice Miller 20 Oct. 1966 178 p
(Grant NsG-87-60)
(NASA-CR-82598; SAO Special Rept.-225) CFSTI: $3.00 CSCL 22C

Baker-Nunn field-reduced photographs were used in calculating satellite orbit data for the tables presented. As opposed osculating elements, the elements presented are mean elements in the sense that the effects of the short-period perturbations due to the earth's oblateness have been eliminated. These mean elements are derived from observations covering several days and are given in the form of a table for satellites such as: Explorer I, Vanguard, Relay, Telstar, and Echo, Injun III. Smooth elements were derived from observations covering about 2 weeks or more, and are given as functions of time. R.U.

31 SPACE VEHICLES

Includes launch vehicles; manned space capsules; clustered and multistage rockets; satellites; sounding rockets and probes; and operating problems. For basic research see: 30 Space Sciences. For related information see also: 28 Propulsion Systems; and 32 Structural Mechanics.

N67-19417*# General Dynamics/Convair, San Diego, Calif.
LOAD FACTORS FOR KICK STAGE Final Report
J. A. Staley and A. F. Leondis 28 Feb. 1967 215 p refs
(Contract NAS3-7958)
(NASA-CR-72167; GDC-BTD66-196) CFSTI: HC $3.00 CSCL 22B

An 8,800-pound cryogenic Kick Stage, considered as a third stage for the Atlas–Centaur rocket combination, is analyzed to determine the load factors developed during launch and flight until the last Kick Stage main engine cutoff. The load factors are intended to provide an accurate basis for design of the basic Kick Stage structure (not small components). Required clearance inside the cone cylinder nose fairing is also considered. Author

N67-18421# European Space Vehicle Launcher Development Organization, Paris (France).
ELDO TECHNICAL REVIEW, VOLUME 1, NO. 2
Paris, Gauthier-Villars, 1966 91 p refs In ENGLISH, GERMAN and FRENCH
CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. USE OF EXTRA-THIN STAINLESS STEEL STRUCTURES IN THE SECOND STAGE OF EUROPA I P. Lequeux p 65–91 (See N67-18422 08-31)

2. STRUCTURE AND DEVELOPMENT OF THE ELDO THIRD STAGE H. E. Lucke p 93–114 (See N67-18423 08-31)

3. EVALUATION OF VARACTOR PERFORMANCES FOR PARAMETRIC AMPLIFIERS USED IN THE RECEIVER SYSTEM OF THE DOWN RANGE GUIDANCE STATION J. C. Lienard p 115–128 (See N67-18424 08-09)

4. ATTITUDE STABILITY OF AN ORBITING SATELLITE E. Cambi p 129–148 (See N67-18425 08-31)

N67-18422# Nord-Aviation, Paris (France).
USE OF EXTRA-THIN STAINLESS STEEL STRUCTURES IN THE SECOND STAGE OF EUROPA I [UTILISATION DES STRUCTURES EN CLINQUANT D'ACIER INOXYDABLE DANS LE DEUXIEME ETAGE DE LA FUSEE EUROPA I]
Pierre Lequeux *In* ELDO ELDO Tech. Rev., Vol. 1, No. 2 1966 p 65–91 In FRENCH; ENGLISH summary (See N67-18421 08-31) CFSTI: HC $3.00/MF $0.65

The front and rear interstage sections of the second stage of EUROPA I are being built from 17/7 cold-rolled extra-thin stainless steel sheet. This has involved in many cases the design and production of special tooling for the purpose of: shaping corrugated sheets, bonding corrugated sheets back to back to form the core of the structure, bonding the core to the internal claddings, and assembly of unit panels, flanges, flittings, and frames. During manufacture many tests were made to ascertain the mechanical strength of these essentially orthotropic structures. For achieving maximum lightness a theory was propounded and experimentally verified; the formulae arrived at are given. Author (ESRO)

N67-18423# European Space Vehicle Launcher Development Organization, Paris (France).
STRUCTURE AND DEVELOPMENT OF THE ELDO THIRD STAGE [DIE STRUKTUR DER 3. STUFE UND IHRE FERTIGUNGSENTWICKLUNG]
H. E. Lucke *In its* ELDO Tech. Rev., Vol. 1, No. 2 1966 p 93–114 In GERMAN; ENGLISH summary (See N67-18421 08-31) CFSTI: HC $3.00/MF $0.65

The paper gives a survey of the design, development and main assemblies of the ELDO third stage. These are of particular interest, since the third stage represents a new development. The upper, lower, and middle parts of the third stage; the fuel tank; and the satellite and engine suspensions are described in detail. A survey of the present stage of development is given. Author (ESRO)

N67-18425# European Space Vehicle Launcher Development Organization, Paris (France).
ATTITUDE STABILITY OF AN ORBITING SATELLITE
E. Cambi *In its* ELDO Tech. Rev. Vol. 1, No. 2, 1966 p 129–148 refs (See N67-18421 08-31) CFSTI: HC $3.00/MF $0.65

The paper deals with the oscillatory (as opposed to tumbling) motions of an orbiting body around its centre of mass. These librations are stable if their amplitude is always limited in time. The stability of the librations is discussed through a simplified line of approach, made possible by the choice of a natural set of coordinates, allowing the conclusions to be reached with a substantially lower analytical effort than that developed in the existing literature. A comparision of the conclusions shows a substantial agreement, with the exception of some minor descrepancies which could possibly deserve a closer investigation. Author (ESRO)

N67-18434* National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
THE ALOUETTE II SATELLITE
G. L. Nelms, R. E. Barrington, J. S. Belrose, T. R. Hartz (Defence Res. Telecommun. Estab.), L. H. Brace et al [1965] 19 p refs Submitted for Publication
(NASA-TM-X-57352) CFSTI: $3.00 CSCL 22B

The orbital parameters of the Alouette II satellite are listed followed by detailed descriptions of its five experiments. These include: (1) a topside sounder which measures the distribution of electrons in the topside ionosphere as a function of distance from the satellite; (2) a background radio noise experiment which measures the noise environment from about 0.2 to 14 Mc/s; (3) a very low frequency experiment which measures radio frequency emissions from 50 to 30,000 cps; (4) an energetic particle experiment which measures the flux of electrons with energies above 40 KeV, 250 KeV, and 3.9 MeV, the flux of protons with energies above 599 KeV, above 100 MeV, and in the range 1 to 8 MeV, and which measures proton spectra in the range 100 to 800 MeV; and (5) an electrostatic probe experiment which measures electron number density and temperature at two locations near the satellite surface. Alouette II was launched with Explorer XXII in nearly the same orbit to permit nearly simultaneous comparisons between the data obtained by the sounder, VLF, and electrostatic probe experiments in Alouette II and the probes in Explorer XXII, and to provide ion and electron temperature and ion composition data at the height of the satellite for use with the sounder data. R.N.A.

N67-18508*# National Aeronautics and Space Administration, Washington, D. C.
LIFTING BODIES
[1967] 8 p
(NASA Facts, Vol. IV, No. 2) CSCL 22B

The advantages of using the lifting body as a manned reentry and recovery spacecraft are discussed, and its design is described. Among the advantages mentioned are low speed handling and landing capabilities, great lift, and high lift-to-drag ratios. Problems connected with reentry speed, and the transition between space and atmospheric flight are identified. Flight tests and the principle features of structure and components are mentioned. N.E.N.

N67-18567*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
FIRST MAGNETIC FIELD RESULTS FROM THE OGO-2 SATELLITE
Joseph C. Cain, Robert A. Langel, and Shirley J. Hendricks Jul. 1966 22 p refs Presented at the 9th Plenary Meeting of COSPAR, Vienna, 13 May 1966 Submitted for Publication
(NASA-TM-X-55665; X-612-66-305) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Digital samples of the total magnetic field were obtained with a rubidium vapor magnetometer at 0.5 second intervals (accuracy $\pm 2\gamma$) on the OGO-2 (1965-81A) satellite launched October 14, 1965 into an orbit with an inclination of 87.4°, perigee of 414 Km and apogee of 1510 Km. Root-mean-square (RMS) differences between the measured field values and those from previously derived spherical harmonic expansions were computed. The best comparison to the date showed residuals of 47 γ. Computation of fields fit to this limited data sample show RMS deviations of 4.1 γ using 143 internal spherical harmonics. The residuals from this field show oscillations near the north pole of a few tens of gammas amplitude, and irregular structure elsewhere of the order of a few gammas. Author

N67-18576* Tracerlab, Inc., Richmond, Calif.
SAFETY ANALYSIS REPORT FOR SELF-LUMINOUS SOURCES USED ON APOLLO SPACECRAFT
20 Jan. 1967 74 p
(Contract NAS9-5117)
(NASA-CR-65577) CFSTI: $3.00 CSCL 22B

Promethium 147 microspheres in self-luminous disks are considered feasible for use on Apollo spacecraft because they cannot cause exposures of biological significance. This conclusion is supported by examination of both the reentry trajectory characteristics of returning spacecraft components, and the radiation mechanisms resulting from programmed or random return to earth of systems or modules with Pm-147. Apollo launch vehicles and mission profiles are briefly discussed, and construction details of the self-luminous sources and their components are included. Function, physical description, and location are noted for the docking ring, bail handle, docking handle, and switch tips of the light source. Dispersion of self-luminous sources and microspheres is discussed, and potential radiation exposure is considered for intact systems and individual sources. An entry heating analysis is included for the command module docking ring and service module bail handle. M.W.R.

N67-18580* Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.
REPORT ON THE DEVELOPMENT OF THE MANNED ORBITAL RESEARCH LABORATORY (MORL) SYSTEM UTILIZATION POTENTIAL. TASK AREA IV: MORL SYSTEM IMPROVEMENT STUDY--BOOK 5
A. Pisciotta Jan. 1966 396 p
(Contract NAS1-3612)
(NASA-CR-66293; SM-48819B) CFSTI: $3.00 CSCL 22B

Integration of the updated bipropellant and advanced thruster systems with the Manned Orbital Research Laboratory (MORL) is detailed to provide a basis for a comparision of the complete integrated MORL propulsion/reaction control systems. Flight mechanics stabilization and control are considered, as are environmental control and biological waste from the crew. Interfaces between the thrustors and the baseline MORL configuration and structure are discussed in detail. Other aspects of systems integration considered are logistics resupply, the power system, and crew and missions operations. Development plans are included for updated bipropellant, resistojet, and radioisotope thrustor systems. Functional requirements, preliminary design specifications, and operational details are defined for the propulsion/reaction control system that will be used to provide control impulses to the space laboratory. An exhaust plume analysis, a reliability analysis, radioisotope thrustor shielding curves, and pressure spikes associated with vacuum ignition are described. M.W.R.

N67-18625*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
MARINER MARS 1964 PROJECT REPORT: SPACECRAFT PERFORMANCE AND ANALYSIS
15 Feb. 1967 273 p refs
(Contract NAS7-100)
(NASA-CR-82154; JPL-TR-32-882) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Mariner IV performance is reviewed from the standpoint of overall system behavior with emphasis on the effects of individual subsystem behavior on overall spacecraft performance. Spacecraft performance is also analyzed on an individual subsystem basis with each subsystem described in sufficient detail that subsystem performance data can be easily interpreted. All inflight performance anomalies and failures are described and recommendations are made for improvement in spacecraft equipment and space flight operations techniques. The Spacecraft Performance Analysis and Command Group (SPAC) organization and function is described; SPAC line and flight organizations, operations philosophy, and interfaces with other organizations involved in Mariner IV flight support are discussed; and an evaluation of SPAC effectiveness are given. Planning methods used by SPAC in preparation for key flight sequence events are presented. The various command sequences and spacecraft operating modes proposed during the flight are discussed in detail along with the reasons for selection or rejection. Author

N67-18689*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
INTERIM FLIGHT REPORT, ANCHORED INTERPLANETARY MONITORING PLATFORM AIMP I—EXPLORER XXXIII
J. J. Madden Dec. 1966 57 p refs
(NASA-TM-X-55863; X-724-66-588) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The first Anchored Interplanetary Monitoring Platform was launched on July 1, 1966, into a highly eccentric earth orbit alternate mission instead of the proposed lunar orbit. The alternate mission was chosen because the over performance of the vehicle precluded a captured lunar orbit. The orbital elements of the achieved orbit vary rapidly. In general, for the first six months the apogee will remain between 400,000 km and 530,000 km and the perigee between 30,000 km and 100,000 km. The closest approach to the moon (35,000 km) occurred on the initial orbit. The launch operations, orbit, and spacecraft performance are discussed based on the first three months of data. Some predicted parameters are also included. Author

N67-18724*# National Aeronautics and Space Administration, Washington, D. C.
SIGNIFICANT ACHIEVEMENTS IN SPACE APPLICATIONS, 1965
1966 91 p refs
(NASA-SP-137) GPO: HC $0.45; CFSTI: MF $0.65 CSCL 22A

CONTENTS:

1. SATELLITE COMMUNICATIONS AND NAVIGATION D. P. Rogers p 3–7 (See N67-18725 08-31)
2. SATELLITE GEODESY J. K. Gisim and N. G. Roman p 11–14 refs (See N67-18726 08-30)
3. SATELLITE METEOROLOGY W. C. Spreen, R. H. McQuain, and G. Tennyson, Jr. p 17–65 refs (See N67-18727 08-20)

N67-18725*# National Aeronautics and Space Administration, Washington, D. C.
SATELLITE COMMUNICATIONS AND NAVIGATION
Donald P. Rogers *In its* Significant Achievements in Space Appl., 1965 1966 p 3–7 (See N67-18724 08-31) GPO: HC $0.45; CFSTI: MF $0.65

A brief review on the various operational commercial communications satellites and their orbital performance is given with emphasis on the design of a satellite capable of being used in either a phased medium-altitude system or a synchronous system. Progress is reported in the development of various techniques for satellite communication utilizing more simplified and inexpensive ground stations with several links in simultaneous use. Also mentioned are some foreign first generation experimental communications satellites. G.G.

N67-18738*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
NASA SOUNDING ROCKET SURVEY FOR FUTURE DEVELOPMENT
Oct. 1966 20 p
(NASA-TM-X-55665; X-721-66-409) CFSTI: HC $3.00/MF $0.65 CSCL 22D

A survey for the future development of sounding rockets is presented in the form of a questionnaire. Background information

to aid in filling out the form is given, and includes (1) a tabulation of currently used vehicles, (2) the performance capabilities of the vehicle payload systems listed, (3) a display of the external configurations of the rockets currently stocked or on order, (4) an outline drawing of those vehicles under study, and (5) the various control and point systems which are now available or under development for Aerobees and other vehicles. The questionnaire generates information as to the number of rockets anticipated, the launch site desired, telemetry and instrumentation, the rocket position determining system, attitude control systems, payload recovery systems, and miscellaneous information. C.T.C.

N67-18756*# National Aeronautics and Space Administration, Washington, D. C.
TWO OSO'S SCHEDULED IN SERIES
2 Mar. 1967 33 p
(NASA News Release-67-32) Available from the Scientific and Technical Information Division CSCL 22B

Presented are data on two Orbiting Solar Observatories (OSO) designated OSO-E and OSO-D which will be used to study the Sun and its influence on the Earth's atmosphere. OSO-E will be orbited by a Delta Launch Vehicle into a 350-mile circular orbit no earlier than March 8, 1967 and OSO-D will follow 60–90 days later. OSO-E and OSO-D will each carry nine experiments which are designed to study the structure, dynamics, and chemical composition of the outer parts of the solar atmosphere through X-rays, visible and ultraviolet radiation. Pointed and wheel experiments of the OSO-E and OSO-D are detailed. Included are data on the OSO spacecraft sail and wheel structure, automatic spin control system, sail control system, automatic pitch control system, magnetic torque coil, aspect monitoring system, and onboard communications system. Improvements over previous OSO spacecraft as a torque coil to augment the automatic pitch control system, and an improved ground command system for emergency control, are cited. Also included are data on the delta launch vehicle and its launch sequence; major launch events; and tracking, data acquisition, and command stations. S.C.W.

N67-18757*# National Aeronautics and Space Administration, Washington, D. C.
[APOLLO 204 REVIEW BOARD ACTIVITIES] Second Interim Report
Robert C. Seamans, Jr. 15 Feb. 1967 4 p
(NASA News Release-67-28) Available from the Scientific and Technical Information Division CSCL 22B

Progress on the Apollo 204 Review Board's investigation of the Apollo accident is reported. Tasks have been assigned to 21 panels and an activity schedule established which is reviewed daily to coordinate and integrate all activities, analyses, and studies. The spacecraft is being photographed in color and mapped in detail using a three-dimensional coordinate system to which all spacecraft elements can be referred. A data control system was implemented that permits a visual display against a time-line background of each step of the investigation. The work and procedures being used in investigating the fire's origin and propagation were reviewed and found satisfactory. The physical evidence thus far shows the fire had considerable variation and directionality and may have had more than one phase. To date, the source of the ignition has not been determined. Information obtained from an onboard biosensor and from a high fidelity recording of background sounds is being analyzed. The condition of the crew's personal effects, suits, and equipment as well as data on their actions during the accident were reviewed. Spacecraft disassembly is proceeding with great care. R.N.A.

N67-18758*# National Aeronautics and Space Administration, Washington, D. C.
[APOLLO 204 REVIEW BOARD MEETINGS] Third Interim Report
Robert C. Seamans, Jr. 25 Feb. 1967 13 p
(NASA News Release 67-38) Available from the Scientific and Technical Information Division CSCL 22B

A memorandum on the interim report of the Apollo Review Board's investigation of the Apollo 204 accident, is reported. Cited are significant information of tentative findings concerning the circumstances of the accident. Ignition sources under review include: possible chemical reactions, such as those in the on-board batteries or in the air purifier of the environmental control unit; possible spontaneous combustion of certain materials used in the spacecraft; and possible electrical phenomena, such as electro-static spark discharges, electrical arcing, or wiring overheating from shorts or malfunctions. Summarized are the Board's theories and supporting evidence concerning the initial location, propagation mechanisms, and phasing of the fire. Principal preliminary recommendations of the Board which are designed to assist in making decisions concerning the continuing Apollo program effort prior to completion of the Board review are also summarized. In addition, the Board has drawn attention to a number of components, subsystems, techniques, and practices which it feels can be improved to increase crew safety and mission reliability. These include findings on the environmental control system solder joints, location of wiring, electrical equipment qualification and design, and the development of checkout procedures. Also emphasized is the Board's recommendation that pressurized oxygen no longer be used in pre-launch operations. S.C.W.

N67-18761*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
NIKE APACHE PERFORMANCE HANDBOOK
Howard L. Galloway, Jr. and Ruth Ann Crough (Fairchild Hiller Corp.) Dec. 1966 113 p refs
(NASA-TM-X-55700; X-721-66-569) CFSTI: HC $3.00/MF $0.65 CSCL 22D

Aerodynamic and performance data on the Nike Apache two-stage solid-propellant sounding rocket system are presented for the various configurations commonly flown. Calculations of vehicle stability and of speed, altitude, and range versus time and payload weight are presented graphically, together with flight-test data on lateral and longitudinal accelerations during the boost phases, for use in determining maximum performance of any given configuration as a function of various parameters. This information updates performance data presented previously in that it contains revised calculations of the above parameters and additional information, both graphs and tables, for rockets flown from sea level and from 3986 above sea level; the results of a dispersion study of impact range; and the results of a postflight program-verification study. Author

N67-18947*# National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.
AN ORBITAL FACILITY FOR LOW GRAVITY FLUID MECHANICS EXPERIMENTS
H. E. Worley, F. M. Bugg, and H. J. Buchanan 27 Dec. 1966 34 p refs
(NASA-TM-X-53551) CFSTI: HC $3.00/MF $0.65 CSCL 22A

A rotating, cable-connected space laboratory for conducting extensive low gravity fluid mechanics experiments is described. The advantages of the various types of existing experimental facilities are discussed in terms of the proposed facility. Existing low-g sloshing data are reviewed. The additional information needed is outlined, and a series of experiments for obtaining this information is proposed. Author

N67-18966*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THRUST VECTOR CONTROL REQUIREMENTS FOR SOLID PROPELLANT LAUNCH VEHICLES
Fred Teren, Kenneth I. Davidson, and Janos Borsody Washington, NASA, 1967 31 p refs
(NASA-TM-X-52276) CFSTI: HC$3.00/MF$0.65 CSCL 22D

Thrust vector deflection angle (TVDA) requirements are calculated for two different launch vehicles—the Phase II 260-inch solid S-IVB, and a large solid launch vehicle (SSOPM) designed to deliver one million pounds of payload to a 100 n. mi. circular orbit. For the S-IVB vehicle, two payload shroud configurations, representing the Apollo and the extended Voyager configurations, were studied, along with a family of shroud shapes and densities to determine the effects of these parameters on control requirements. To control the vehicle during peak wind loads, it was found that approximately 1.6° is required for the extended voyager vehicle, and about 1° for both the Apollo and the SSOPM. In general, the TVDA needed is a function of the vehicle and trajectory parameters, as well as payload shroud density and shape. Studies on the use of aerodynamic control surfaces for reducing the TVDA requirements indicate that either movable canards or fixed fins are effective.
M.G.J.

N67-18982*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
APPLICATIONS TECHNOLOGY SATELLITE GRAVITY GRADIENT STABILIZATION SYSTEM Quarterly Progress Report, 1 Jul.–30 Oct. 1966
15 Nov. 1966 93 p
(Contract NAS5-9042)
(NASA-CR-82465; Doc.-66SD4505; QPR-9) CFSTI: HC $3.00/MF$0.65 CSCL 22B

Technical progress toward the design and development of gravity gradient stabilization systems for the Applications Technology Satellites (ATS) is reported. The ATS math model computer program was checked out, and computations were obtained for vehicle attitude dynamics. It was found that the major contributor to boom deflection in orbit is the thermal bending component, and empirical and analytical approaches for determining the magnitude of rod bending are described. The computer processing system to be used for evaluation of the ATS-A and determination of attitude is specified, and final performance estimates for the ATS-A and ATS-D are presented. Other areas covered include qualification testing of mounting brackets, details of the solar aspect sensor system, and system compatibility testing.
C.T.C.

N67-19013* Booz-Allen Applied Research, Inc., Bethesda, Md.
OGO-GAS BUDGET COMPUTATION: DESCRIPTION OF PROGRAM AND PRESENTATION OF COMPUTED GAS BUDGETS
Aug. 1966 126 p refs
(Contract NAS5-5742)
(NASA-CR-82669; Rept.-662-3T29-1) CFSTI: $3.00 CSCL 22B

A digital computer program for estimating Polar Orbit Geophysical Observatory (POGO) and Eccentric-orbit Geophysical Observatory (EGO) attitude control gas budgets was checked. It was found that the total gas available would be exhausted within 2 months of the launch epoch, and the initial perigee was boosted to 200 n.m., thereby raising the lifetime to about 7 months. Consideration is given to torques due to aerodynamic and solar pressures, and gravity gradient. Analysis revealed that aerodynamic yaw torque was the major cause of gas expenditure up to an initial perigee altitude of about 200 n.m.; gravity-gradient yaw accounted for the other major source of torque. A parametric analysis was made of gas budget dependence upon orbital inclination to the sun vector, and the angular position of perigee relative to the projection of the sun vector onto the orbital plane. The computer program computes gas expenditure per orbital cycle, and total expenditure over a 12-month period is estimated by sampling orbits at intervals throughout. Gas budgets reported were based upon sampling orbitals at 15-day intervals. An appendix describes how initial orbital parameters may be computed from the injection parameters.
R.L.L.

N67-19084*# Massachusetts Inst. of Tech., Cambridge, Aerophysics Lab.
AN INVESTIGATION OF FORCES ON AN OSCILLATING CYLINDER FOR APPLICATION TO GROUND WIND LOADS ON LAUNCH VEHICLES
Leon H. Schindel, Garabed Zartarian, and Peter K. S. Wu Oct. 1966 80 p refs
(Contract NAS8-20186)
(NASA-CR-82504; TR-130) CFSTI: HC $3.00/MF $0.65 CSCL 22D

The effects of model motion on the forces acting on a two-dimensional cylinder are investigated for application to the prediction of ground wind loads on launch vehicles. The wakes behind stationary and oscillating circular cylinders are studied with the aid of a hydrogen bubble flow visualization technique. The paths of wake vortices are examined for a cylinder with a small amplitude negatively-damped oscillation, a larger amplitude damped oscillation, and an oscillation of intermediate amplitude with approximately zero damping. A multiple-vortex analytical model is devised with which it is possible to calculate the periodic motion of the wake vortices and the resulting forces on a stationary cylinder. Possible extensions of the method to the case of an oscillating cylinder are indicated.
Author

N67-19128*# Cornell Aeronautical Lab., Inc., Buffalo, N. Y. Flight Research Lab.
THEORY AND ANALYSIS OF A HIGHLY ELASTIC LAUNCH VEHICLE
Joseph L. Francis Apr. 1966 41 p refs
(Contract NAS8-20067)
(NASA-CR-82451; FDM-377) CFSTI: HC $3.00/MF $0.65 CSCL 22D

Motion equations for the rigid body, the bending modes, and the engine-actuator dynamics were simplified and used in a program designed to investigate optimal control techniques for highly elastic launch vehicles. The shape of the deflected vehicle was obtained by summarizing the following mode shapes: (1) the liquids in the tanks were considered rigid in the sectional mass distribution; (2) the engines were rigidly attached with the mass of the engines lumped at the engine center of gravity body station, and (3) the mode slope was constant aft of the gimbal station. Mode shapes were normalized and computed so that no elastic or inelastic coupling was present. An example calculation for an optimal control technique of a highly elastic launch vehicle was given.
G.G.

N67-19378*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
GEMINI LAND LANDING SYSTEM DEVELOPMENT PROGRAM. VOLUME I: FULL-SCALE INVESTIGATIONS
Leland C. Normen, Jerry E. McCullough, and Jerry C. Coffey Washington, NASA, Mar. 1967 175 p refs
(NASA-TN-D-3869) CFSTI: HC$3.00/MF$0.65 CSCL 22B

This report presents the development of a working system which would allow a returning spacecraft to make a soft landing on land or on water. This landing system combines a gliding parachute for maneuver and wind-drift negation capability with retrograde rockets fired just above the surface to reduce the descent velocity prior to impact. The report documents the entire 3-year effort which began with scaled-model tests and concluded with a completely successful full-scale land landing demonstration at Gemini spacecraft design conditions.
Author

N67-19279*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
GEMINI LAND LANDING SYSTEM DEVELOPMENT PROGRAM. VOLUME II: SUPPORTING INVESTIGATIONS
Leland C. Norman, Jerry E. McCullough, and Jerry C. Coffey Washington, NASA, Mar. 1967 464 p *ref*
(NASA-TN-D-3870) CFSTI: HC$3.00/MF$0.65 CSCL 22B

Prior to testing full-scale, many supporting investigations, scaled-model tests, and component development programs were conducted to define and develop the Gemini land landing system. A detailed presentation of these efforts which led to and supported the full-scale investigation is given. Included are two scaled-model system test programs conducted to obtain preliminary flight and landing characteristics of the integrated system, and the development programs for each system component based on the design requirement studies and integration analyses. The physical and functional characteristics of the major hardware items are discussed, and the verification tests of these items are reviewed. Presentations of the data acquisition system and the sequencing system are also included. A.G.O.

32 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic.

N67-18204# Lockheed Missiles and Space Co., Palo Alto, Calif.
METHOD OF INVESTIGATING PLASTIC STRAIN PROPAGATION UNDER DYNAMIC LOADING
V. P. Severdenko and R. L. Ryzhkovich [1966] 2 p refs Transl. into ENGLISH from Dokl. Akad. Nauk Belorussk. SSR (Minsk), v. 10, no. 11, 1966 p 847–848

A scheme for investigating the influence of inertial forces on strain propagation over a sample under the effect of dynamic loading is described. According to this scheme, the sample is replaced by a system consisting of two identical cylindrical samples of the material under study and a rigid body whose mass changes within broad limits during the experiment. After impact by a hammer, the upper and lower samples receive differing degrees of strain, eventually resulting in the upper sample being strained more. It is assumed that the scheme is a dynamic model of a long homogeneous sample, whose mass equals the mass of the whole system. As the mass changes, the samples afford the possibility of investigating the behavior of a metal at different distances from the impacting end, and in particular, of investigating the propagation of plastic strain as a function of the velocity of the impacting body. Samples of practically unbounded length can be simulated with the aid of this scheme. S.C.W.

N67-18205# Lockheed Missiles and Space Co., Palo Alto, Calif.
PLANE ONE-DIMENSIONAL WAVE PROPAGATION ON IMPACT IN A PLASTIC MEDIUM
E. I. Andriankin [1960] 7 p refs Transl. into ENGLISH from Tr. Mosk. Fiz.-Tekhn. Inst. (Moscow), no. 5, 1960 p 55–61

Shock propagation in a medium admitting variable compression on the shock front is investigated. It is assumed that the shock originates under the effect of an instantaneously applied pressure which drops according to a given law. The sound velocity in the compressed medium is taken as constant or infinite. Author

N67-18206# Lockheed Missiles and Space Co., Palo Alto, Calif.
ON PLASTIC ANALYSES OF THICK-WALLED CYLINDERS
V. I. Rozenblium [1966] 6 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Mekh. Tverdogo Tel (USSR), no. 4, 1966 p 133–137

Previous findings regarding the ideal plastic state of a long, thin-walled circular pipe uniformly loaded by external pressure and an axial force are re-examined, and conclusions are drawn for the case of thick-walled cylinders. Considered is also a unified approach to problems involving plastic inhomogeneity, strengthening, and creep. Results are evaluated to illustrate the predominant value of a state of total plasticity for piecewise-linear criteria in axisymmetric flow. The analyses are based on a geometric interpretation of the stress conditions. K.W.

N67-18208 Lockheed Missiles and Space Co., Palo Alto, Calif.
PROPAGATION OF CYLINDRICAL STRESS SHOCKWAVES IN A PLATE BEYOND THE ELASTIC LIMIT
V. N. Kukudzhanov [1966] 11 p Transl. into ENGLISH from Tr. Mosk. Fiz.-Tekhn. Inst. (Moscow), no. 3, 1959 p 108–120

The propagation of cylindrical waves originating in a plate with a circular hole subjected to an axisymmetric impact loading applied to the edge of the hole is investigated. Dynamic dependences taking account of the influence of the strain rate are assumed between the stresses and strains. Some questions associated with the propagation of cylindrical waves in plates beyond the material yield point have been investigated without taking account of the strain-rate effect. Author

N67-18218 Lockheed Missiles and Space Co., Palo Alto, Calif.
INTEGRAL OPERATOR METHOD IN THE THEORY OF VIBRATIONS OF ANISOTROPIC BODIES WITH CREEP
N. N. Dolinina [1965] 5 p refs Transl. into ENGLISH from Dopovidi Akad. Nauk Ukr. RSR (Kiev), no. 10, 1966 p 1276–1279

Consideration is given to solution of dynamic problems of the hereditary theory of creep of anisotropic bodies in a linear formulation by utilizing the Volterra principle. The problem of vibrations in rectangularity of an orthotropic plate with four simply supported sides is presented as an example. The creep of the material is taken into account. The Volterra principle, or integral operator method, is applied without restriction to cases of forced vibration and free vibration. S.P.

N67-18220# Lockheed Missiles and Space Co., Palo Alto, Calif.
DETERMINATION OF THE DYNAMIC "STRESS–STRAIN" CURVE WITH AN INFLECTION POINT
K. A. Kerimov [1963] 5 p refs Transl. into ENGLISH from Dokl. Akad. Nauk Azerb. SSR (Baku), v. 19, no. 4, 1963 p 11–16

Results of an investigation on an impact apparatus are presented, and dynamic T(e) stress diagrams are constructed up to the limit of dynamic failure according to methods worked out for industrial rubber. An experimental method of direct measurement of the tension and strain by using an electronic meter and a recording apparatus is also described. In order to compare results, a diagram is constructed for the same rubber by the method of recharging impulses. Author

N67-18275# Aeronautical Research Council (Gt. Brit.)
TWO-DIMENSIONAL NORMAL FENCES ON A FLAT PLATE
C. S. Barnes London, HMSO, 1966 25 p refs Supersedes ARC-26877
(ARC-CP-863; ARC-26877) CFSTI: HC$3.00/MF$0.65

As a first step towards understanding the mechanism of action of spoilers, two-dimensional normal fences on an effectively infinite flat plate in incompressible flow were studied experimentally. The pressure distribution on the plate upstream of a fence was found to be a function of σ^*/h, where σ^* is the boundary layer

displacement thickness measured at the fence position, in the absence of the fence, and h is the fence height. Downstream, the pressure distribution in the separated region was a function of nondimensional distance from the fence and the reattachment distance was proportional to h. Downstream of reattachment a dependence on σ^*/h was once again apparent. Author

N67-18279# Aeronautical Research Council (Gt. Brit.)
ALLEVIATION OF THERMAL STRESSES IN AIRCRAFT STRUCTURES
E. C. Capey London, HMSO, 1965 27 p refs Supersedes RAE-TR-64055; ARC-26725; see X65-15546
(ARC-CP-819; RAE-TR-64055; ARC-26725) CFSTI: HC $3.00/MF $0.65

Methods of alleviating thermal stresses in aircraft structures are discussed under two headings: cooling and external insulation, and structural design against thermal stresses. The advantages and disadvantages of each method are noted, and the effectiveness is illustrated in some cases by numerical examples. Mention is made of the stresses in honeycomb sandwich and at the boundaries of fuel tanks. Author

N67-18284# General Dynamics Corp., San Diego, Calif. Special Nuclear Effects Lab.
TAYLOR INSTABILITY OF A FLAT PLATE
J. W. Miles 4 Aug. 1966 16 p ref
(Contract AF 29(601)-7155)
(GAMD-7335; AD-643161) CFSTI: HC $3.00/MF $0.65

A flat plate experiences a transverse acceleration under the action of a pressure that also produces plastic yielding throughout the plate. Taylor instability is considered on the assumptions of a single degree of freedom, incompressible flow, and the Prandtl–Reuss constitutive equations in the limiting cases of (a) infinitesimal perturbations and (b) rigid-plastic flow (yield stress/shear modulus approaches 0). Author (TAB)

N67-18291# Brown Univ., Providence, R. I. Div. of Engineering.
SOME CALCULATIONS ON CREEP IN A PRESSURISED THIN SPHERICAL SHELL WITH AN OPENING
C. R. Calladine Oct. 1966 52 p refs
(Contract Nonr-562(20))
(Nonr-562(20)/51; TR-51; AD-643181) CFSTI: HC $3.00/MF $0.65

Calculations were performed on a pressurised thin spherical shell with a sealed opening for material obeying a simple r-power steady creep law; they were done by an iterative procedure on an IBM7090 computer. The results, in terms of stress resultant distributions and deformation patterns in the neighbourhood of the opening for different edge load boundary conditions, were examined critically with a view to detecting simple overall patterns of behaviour which are a function of the creep index r. Examination of the results from two different points of view leads to the conclusions that stress concentration factors vary smoothly and almost linearly with 1/r and that deformation patterns are practically independent of r, for the same edge load boundary conditions. The strain rate concentration factors may be very high. The consequences of these conclusions are examined in the context of the design process. Author (TAB)

N67-18323*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
STRUCTURAL ANALYSIS AND MATRIX INTERPRETIVE SYSTEM COMPUTER PROGRAM
J. R. Chisholm *In its* Space Programs Sum. No. 37–42, Vol. IV 31 Dec. 1966 p 67–68 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

The functional capabilities of this general purpose computer program, developed to analyze frame and shell type structures, are described. Program development considerations were given to modularization of the program for functionally diverse applications and reduction of errors in program usage. Numerical techniques of the finite element method were developed to analyze the more general shell loading cases and nonhomogeneous shell constructions. R.N.A.

N67-18378 Aeronautical Research Council (Gt. Brit.)
VERTICAL ACCELERATIONS DUE TO STRUCTURAL VIBRATIONS OF A SLENDER AIRCRAFT FLYING IN CONTINUOUS TURBULENCE
J. K. Zbrozek London, HMSO, 1966 55 p refs Supersedes RAE-TN-AERO-2901, ARC-25205; see N65-25350
(ARC-CP-842; RAE-TN-AERO-2901; ARC-25205) HMSO: 11s

A numerical study is made of the vertical accelerations due to structural vibrations of a slender aircraft flown in continuous turbulence. The basic aircraft configuration considered is that used in previous aeroelastic studies, but the analysis is extended to cover the effects of aircraft size, airframe stiffness, wing loading, lift slope and speed and altitude of flight. Only the first structural mode is studied in some detail, but the order of the effects of the rigid body mode and higher structural modes are investigated also. It is concluded, that for a configuration approximating to a future supersonic transport design, the vertical vibrations should be quite acceptable for passengers but, in some conditions may impair crew efficiency. Author

N67-18411*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THE AXIALLY SYMMETRIC RESPONSE OF AN ELASTIC CYLINDRICAL SHELL PARTIALLY FILLED WITH LIQUID
Richard M. Beam and Le Roy R. Guist Washington, NASA, Feb. 1967 43 p refs
(NASA-TN-D-3877) CFSTI: HC $3.00/MF $0.65 CSCL 20K

The axially symmetric response of a circular cylindrical shell partially filled with a liquid and subjected to axial displacements and pressurization fluctuations is investigated analytically and experimentally. Two solutions are presented: one, an "exact" series solution and the other, an approximate solution. The correlation of theoretical and experimental results indicates that the theory presents a good mathematical model of the physical system and that the approximate solution is adequate for many practical problems. Author

N67-18420* Schjeldahl (G. T.) Co., Northfield, Minn.
PASSIVE GEODETIC SATELLITE INFLATABLE SPHERE ASSEMBLIES
S. J. Stenlund, G. A. Dahlgren, A. J. Wendt, D. Lingo, D. Roiseland et al [1966] 98 p Sponsored by NASA
(NASA-CR-66274) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The construction of the PAGEOS (Passive Geodetic Satellite) 30.48-meter-diameter inflatable sphere is described in detail, from design analysis, through design testing, manufacturing and inspection, to the final packing in a canister. An original method is derived for predicting the reliability of the sphere, without demonstration tests or predetermined component failure rates. The sphere was put in orbit on June 23, 1966. Author

N67-18482* Astro Research Corp., Santa Barbara, Calif.
DEPLOYABLE TENSION-SHELL DECELERATORS Technical Summary Report
Richard H. Mac Neal and Albert C. Kyser 28 Oct. 1966 24 p refs
(Contract NAS1-5805)
(NASA-CR-66258; ARC-R-229) CFSTI: $3.00 CSCL 22B

Structural characteristics of deployable tension-shell decelerators were investigated. The configuration studied consists of a flared conical membrane that is stabilized by a pressurized, filament-wound toroid at the base. A theoretical analysis and experimental verification was made of the design of the pressurized toroid for deployment and for buckling under load, and of flutter in a towed configuration. A flexible tension-shell decelerator can be made to deploy reliably into a high-q environment; and structural performance during and after deployment can be adequately predicted by elementary theory. The flutter investigations indicated the need for proper mass balance in a towed configuration, and the probable requirement for membrane shear stiffness in the tension shell. Author

N67-18514 Joint Publications Research Service, Washington, D. C.
ON THE RANDOM VIBRATION OF ELASTIC PLATE
Tseng-yang Huang *In its* Transl. on Communist China's Sci. and Technol., No. 356 20 Dec. 1966 p 29–41 refs (See N67-18511 08-34) CFSTI: $3.00

The random vibration of an elastic plate submerged in water is discussed, and related to the method of Fourier transformation and expansion in eigenfunctions. The reaction of the medium to the vibrating plate was investigated strictly under the conditions that excluded the interaction between the different modes. The range in which the Dirac δ function might be used to describe the correlation function of the quasi-sound field in the turbulent boundary level was based on the experimental results of the last years. Author

N67-18552 Lockheed Missiles and Space Co., Palo Alto, Calif.
SOME BOUNDARY VALUE PROBLEMS OF ELASTICITY THEORY FOR TRANSVERSALLY ISOTROPIC CYLINDER
R. Is. Suncheleev [1965] 6 p refs Transl. into ENGLISH from Izv. Akad. Nauk UZ SSR, Ser. Fiz. Mat. Nauk (Tashkent), no. 5, 1966 p 41–47

A class of static problems of elasticity theory for a transversally isotropic cylinder is considered. By utilizing the method presented, it is possible to obtain the appropriate solutions in the general case. As an application of the results, solutions are given for the fundamental boundary value problems for a solid and a hollow transversally isotropic elastic cylinder for given boundary conditions on the lateral surface. Author

N67-18560# Lockheed Missiles and Space Co., Palo Alto, Calif.
ON THE VIBRATIONS OF TWO ECCENTRICALLY DISPOSED CYLINDRICAL SHELLS IN AN INVISCID FLUID FLOW
V. N. Bulvol and A. N. Guz [1966] 4 p refs Transl. into ENGLISH from Dopovidi Akad. Nauk Ukr. RSR (Kiev), no. 11, 1966 p 1412–1415

A mathematical analysis is presented for the fluid and shell motions for the combination of a thin elastic cylindrical shell enclosing a second, eccentrically disposed, cylindrical shell. An example is included, and computations are tabulated which yield the first representations on the nature of the change in apparent mass of an incompressible fluid in the axisymmetric vibrations of a shell. N.E.N.

N67-18637*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
VIBRATION AND BUCKLING OF PRESTRESSED SHELLS OF REVOLUTION
Paul A. Cooper Washington, NASA, Mar. 1967 41 p refs
(NASA-TN-D-3831) CFSTI: HC$3.00/MF$0.65 CSCL 20K

A linearized set of equations is developed for the infinitesimal vibration and buckling of an axisymmetrically prestressed thin shell with an arbitrary meridional configuration. A finite-difference numerical procedure is given for finding the natural frequencies, buckling loads, and associated mode shapes, and the procedure is applied to calculation of natural frequencies of an unstressed, simply supported cylinder. A closed-form solution is obtained for the simply supported cylinder and is used to verify the numerical procedure, which is then used to solve some other example problems including the vibrations of particular shells of zero and positive Gaussian curvature. Author

N67-18679 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
STUDY OF PLASTICITY AND FLUIDITY DESIGNED TO CALCULATE THE RESISTANCE OF STRUCTURES [ETUDES DE PLASTICITE ET FLUAGE DESTINEES AUX CALCULS DE RESISTANCE DES STRUCTURES]
Jean Lemaitre *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 32 (See N67-18661 08-34) CFSTI: $3.00

For aerospace technology application, abstracted conference papers report the plasticity and stress relationships in structural resistance tests. Deformation velocity and stress behavior, statistical calculation techniques, and improved testing methods are very briefly outlined. Transl. by R.Ll.

N67-18680 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
THE AEROELASTIC INSTABILITIES IN THE FLYING STRUCTURES [LES INSTABILITES AEROELASTIQUES DANS LES STRUCTURES VOLANTES]
Rolland Dat *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 33 (See N67-18661 08-34) CFSTI: $3.00

In a study of aeroelastic instability of aircraft structures, aerodynamic characteristics of wing panels were calculated. Wind tunnel testing indicated that the boundary layer at the wall has a relative effect and that the deviation between theoretical aeroelastic instability and wind tunnel results shows a reasonable ratio in consideration of the three-dimensional theory. Transl. by R.Ll.

N67-18681 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
THE UNDERSTANDING OF AEROSPACE STRUCTURES BY GROUND VIBRATION TEST [LA CONNAISSANCE DES STRUCTURES AEROSPATIALES PAR L'ESSAI DE VIBRATION AU SOL]
Christian Beatrix *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 34 (See N67-18661 08-34) CFSTI: $3.00

Summary details are presented on vibration ground testing in relation to aerospace structures. The supposedly linear, kinematic condition of structures is emphasized, and the experimental method consists in obtaining technical data on structural response to a harmonic excitation process. The method was devised to prevent aeroelastic instability and finds much application in aerospace technology. Transl. by R.Ll.

N67-18688*# General Dynamics/Convair, San Diego, Calif.
FABRICATION PROCESS DEVELOPMENTS OF A STRUCTURAL MODEL FOR RESEARCH ON HYDROGEN-FUELED HYPERSONIC VEHICLES
John C. Hopkins Feb. 1967 87 p refs
(Contract NAS1-4017)
(NASA-CR-66198) CFSTI: HC$3.00/MF$0.65 CSCL 22B

A structural model was fabricated which was designed to test a new structure and insulation concept and establish that it was practical to manufacture as part of a research study on hydrogen-fueled hypersonic vehicles. The model represents a fuselage section of a hydrogen-fueled vehicle. It has a welded outer structure of annealed René 41. This primary structure is made of

sheet metal skins, Zee stringers, and frames fastened together with resistance and fusion spotwelds. Machined ring forgings are fusion seam welded to the forward and aft ends of the structure. A liquid hydrogen tank is suspended within the primary structure by means of draw formed Inconel 718 bellows which permit expansion and contraction. The tank was made of 2219 aluminum machined and formed panels, explosive formed dome ends and access door. The tank components are joined by fusion welding. An access door bolts to the tank, and a plastic seal prevents leakage. Author

N67-18882*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
STRESSES IN A COMPRESSIVELY LOADED CIRCULAR SEMIMONOCOQUE CYLINDER WITH A CUTOUT
R. E. Martin Washington, NASA, Feb. 1967 30 p refs
(NASA-TM-X-1354) CFSTI: HC$3.00/MF$0.65 CSCL 20K

The results of an experimental program to determine the stresses in a stiffened cylinder with a cutout and the cylinder loaded in axial compression are presented. Three cutout sizes were considered in the program, and stringer loads and skin panel shear flows are presented in graphic form for the three sizes. One test cylinder was used for all cutout cases, and the cutout size was successively enlarged. Strain measurements were made with resistor-type strain gages on the skin panels and stringers. A stress perturbation technique was used to determine the stringer loads and skin panel shear flows. These stringer loads and panel shear flows predicted by this analytical method are compared with the experimental results obtained in this program. Author

N67-18716 Lockheed Missiles and Space Co., Palo Alto, Calif.
ON PLATE VIBRATIONS IN A GAS FLOW
G. A. Marchenko and A. P. Filippov [1966] 5 p refs Transl. into ENGLISH from Prikl. Mekh. RSR (Kiev), v. 2, no. 11, 1966 p 133–137

The possibility of investigating the dynamic stability of plates in a gas flow by direct application of the Lagrange variational equation for elastic equilibrium is demonstrated. Difficulties arising in the selection of the coordinate functions are eliminated. Approximate results which are in good agreement with the exact solutions of some nonconservative programs, are presented. New results are obtained for cantilever trapezoidal plates. L.S.

N67-18780 Lockheed Missiles and Space Co., Sunnyvale, Calif.
ON A CASE OF THE EQUILIBRIUM OF A SYSTEM OF CRACKS IN AN ELASTICALLY BRITTLE MATERIAL
V. M. Kuznetsov [1966] 4 p refs Transl. into ENGLISH from Prikl. Mekh. i Tekhn. Fiz. (USSR), no. 5, 1966 p 161–163
CFSTI: HC$3.00

Proposed is an approximate method for solving the problem of the equilibrium of a system of parallel cracks in an elastically brittle material. Also derived were expressions for the problem of stationary propagation of a system of cracks of similar shape, and for a single crack. It is shown that the formulated problem reduces to the Keldysh–Sedov problem of the theory of functions of a complex variable. S.C.W.

N67-18767*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
ECCENTRICALLY STIFFENED SHALLOW SHELLS OF DOUBLE CURVATURE
John A. McElman Washington, NASA, Feb. 1967 34 p refs
(NASA-TN-D-3826) CFSTI: HC$3.00/MF$0.65 CSCL 20K

Equilibrium equations and boundary conditions are derived which govern the buckling and vibration of eccentrically stiffened shallow shells of double curvature. The equations are then solved for the case of simple-support boundary conditions and results are presented which illustrate the effects of eccentric stiffening on the dynamic and buckling characteristics of shells of positive and negative Gaussian curvature. Results show that eccentric stiffening can have a significant effect on the natural frequencies and buckling loads of such shells. Author

N67-18903 Lockheed Missiles and Space Co., Palo Alto, Calif.
ON THE THEORY OF ANISOTROPIC ELASTIC SHELLS AND PLATES
L. I. Libresou [1966] 14 p refs Transl. into ENGLISH from Inzh. Zh. (Moscow), v. 4, no. 3, 1964 p 475–485

A theory of homogeneous anisotropic elastic shells and plates is expounded which is free of the customary simplifying hypotheses. The e_{13} components of the strain tensor as well as the σ^{i3} (i=1,2,3) components of the stress tensor are taken into account. The boundary conditions on the external bounding surfaces of the shell are satisfied rigorously. No constraint is imposed on the shell thickness. On the basis of the obtained general relationships, the problem of thin anisotropic plates is examined. Author

N67-18908# Lockheed Missiles and Space Co., Palo Alto, Calif.
PLANE PROBLEM OF ELASTICITY THEORY FOR BONDED MATERIAL COMPONENTS
V. V. Bolotin [1966] 26 p refs Transl. into ENGLISH from Rachety na Prochnost' (Moscow), no. 12, 1966 p 3–31

The plane stress state and plane strain is considered for an elastic medium bonded by linear or plane elastic elements. A computational model is derived for a plate consisting of a number of flat layers (sheets) which consist of two materials: the bonding material which has high stiffness, and the binder. The parameters referring to the bonding material are provided with a prime; those referring to the binder with a double prime. The macrostructural approach is used to establish a connection between the stresses, strains, and elastic constants for the quasi-homogeneous medium, and the corresponding parameters of the bonding and binding materials. Materials obtainable by the superposition of oriented layers in a different manner are also considered. Examples are given of the application of the elasticity theory to orthotropic materials, as well as to materials with random layer orientation. The influence of the mechanical properties of the components and of the bonding coefficients on the stress distribution in parts of the bonded materials is examined. M.G.J.

N67-18930*# National Aeronautics and Space Administration, Washington, D. C.
STRESS DISTRIBUTION AT THE VERTEX OF A GROWING CRACK [RASPREDELENIYE NAPRYAZHENIY V VERSHINE RASTUSHCHEY TRESTCHINY]
L. B. Zuyev, I. A. Kutkin, and V. M. Finkel' Jan. 1967 8 p refs Transl. into ENGLISH from Prikl. Mekh. i Tekhn. Fiz. (USSR), no. 3, Jun. 1966 p 107–111
(NASA-TT-F-10668) CFSTI: HC$3.00/MF$0.65 CSCL 20K

High-speed motion picture photography is used in combination with the optical polarization method of stress analysis to study the field of elastic stresses at the tip of a crack which is propagating at a rapid rate. It is found that there are a number of singularities of the field which are characteristic only for rapidly propagating cracks and differ considerably from the properties of the field close to a static crack. A knife, a narrow zone of high tangential stresses, develops in front of a rapidly propagating crack. With a further increase in the rate at which the fracture develops in front of the crack, a zone of isochromatic rings develops in which the tangential stress distribution is identical in various directions from the end of the cracks. The stress in this zone decreases linearly with distance from the end. Branching begins at the moment when different stresses are set up in the zone. The reason for branching is hidden in the very nature of crack growth, in transformation of the stress field at high velocity. Author

N67-18946*# Bell Aerosystems Co., Buffalo, N. Y.
GEOMETRICALLY NONLINEAR ANALYSIS OF THE APOLLO AFT HEAT SHIELD Final Report, 1 Apr. 1966–15 Dec. 1966
R. H. Gallagher and R. H. Mallet Dec. 1966 46 p refs
(Contract NAS9-3528)
(NASA-CR-65594; Rept.-7218-933005) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The response of the Apollo heat shield structure is considered under water impact loading conditions. Equivalent static pressure loading is defined to transform the associated analysis problem to one of elastic stability. An analysis method is developed and geometrically nonlinear analyses are conducted to assess the significance of finite displacement effects. The technical approach employed in both analytical formulation and numerical solution is one of a direct attack on the nonlinear problem. This approach enables the realistic utilization of a displacement criterion for the detection of elastic instability. Concepts and procedures embodied in the analysis method are fully explained in the context of the Apollo aft heat shield application. Numerical results are presented to illustrate clearly the effect of finite displacements. This report, together with the associated computer program, provides a basis for further analysis of the Apollo aft heat shield and many other NASA structures. Author

N67-18968*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
INVESTIGATION OF FATIGUE CRACK GROWTH IN Ti–8Al–1Mo–1V (DUPLEX-ANNEALED) SPECIMENS HAVING VARIOUS WIDTHS
C. Michael Hudson Washington, NASA, Mar. 1967 22 p
(NASA-TN-D-3879) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Axial-load fatigue crack propagation tests were conducted on 2-, 4-, 8-, and 20-inch-wide sheet specimens made of Ti–8Al–1Mo–1V (duplex-annealed) titanium alloy to study the effect of specimen width on fatigue crack growth. Both longitudinal- and transverse-grain specimens having a width of 8 inches were studied. Tests were conducted at a mean stress of 25 ksi (173 MN/m^2) and at five alternating stresses with amplitudes ranging from 2 to 25 ksi (14 to 173 MN/m^2). At a given stress level, there was relatively little difference between the fatigue-crack-growth curves for different specimen widths. The resulting data were successfully correlated by using crack propagation analyses. A simple power function relating rate and stress intensity factor was empirically adjusted to fit the test data. Previous findings showed the transition of the specimen fracture surfaces from the tensile to the shear mode to be associated with the change in slope of the semilog plot of rate of crack growth against stress intensity factor. However, inspection of the fracture surfaces of specimens tested in the present investigation showed no such correlation. Cracks grew slightly faster in the transverse grain direction than in the longitudinal direction. Author

N67-19046*# New York Univ., N. Y. Dept. of Aeronautics and Astronautics.
A FURTHER STUDY OF ELASTIC FOUNDATION MODELS
Arnold D. Kerr and Warren J. Rhines Jan. 1967 26 p refs
(Grant NGR-33-016-067)
(NASA-CR-82375; S-67-1) CFSTI: HC $3.00/MF $0.65 CSCL 20K

In order to study elastic foundation models it is shown that the response expression of the Pasternak model can be derived from the continuum point of view when the assumption is made that the in-plane stresses and the in-plane displacements are zero throughout the foundation layer. It is also shown that, by expanding formally the exact pressure-deflection relationship for the upper surface of an elastic layer which rests on a rigid base, the response expressions of a number of models are obtained, the type depending upon the number of terms retained in the expansion. Author

N67-19051*# Wichita Univ., Kans. Dept. of Aeronautical Engineering.
SOME FREE VIBRATION AND DYNAMIC RESPONSE PROBLEMS ASSOCIATED WITH CENTRIFUGALLY STABILIZED DISK AND SHELL STRUCTURES Semiannual Progress Report, 15 Aug. 1966–15 Feb. 1967
Feb. 1967 6 p refs
(Grant NGR-17-003-004)
(NASA-CR-82525) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Progress is reported for a study of free vibration and dynamic response problems associated with centrifugally stabilized disk and shell structures. One of the major tasks completed was the study of natural frequencies of transverse vibrations of a spinning annular membrane with a frictionless hub. The vibrations of shallow spherical membrane shells centrifugally loaded were also examined. The stress distribution in the freely spinning shell was analyzed by use of a linear bending and membrane theory. S.P.

N67-19082# Aeronautical Research Labs., Melbourne (Australia).
ELASTIC STABILITY OF RECTANGULAR SANDWICH PLATES UNDER BI-AXIAL COMPRESSION
B. I. Green and J. Solvey Dec. 1965 130 p refs Revision of Rept. ARL/SM-251
(ARL/SM-310; ARL/SM-251) CFSTI: HC $3.00/MF $0.65

Buckling loads in the elastic range of rectangular sandwich panels having isotropic cores and faces, with four clamped edges and with two opposite edges clamped and two opposite edges simply supported, subjected to bi-axial compression, have been computed using Rayleigh's method. Results are tabulated as well as plotted in terms of non-dimensional parameters. Interaction curves have also been plotted to facilitate practical application. As these particular loading cases have not been computed before, the only comparison available is with the uni-axial compression case, i.e. the case where one of the two loadings, either p_x or p_y is zero. The results obtained were identical. Author

N67-19091*# Arizona State Univ., Tempe. Coll. of Engineering Sciences.
INVESTIGATION OF DYNAMIC BEHAVIOR OF THIN SPHERICAL SHELLS Semiannual Technical Progress Report, 1 Aug. 1966–31 Jan. 1967
James P. Avery 15 Feb. 1967 15 p
(Grant NGR-03-001-013)
(NASA-CR-82507) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Efforts expended this period on the development of a Green's function approach to the vibration problem of thin spherical shell segments are reported. Using an earlier developed method of solution, numerical solutions were attempted for two fundamental problems: 1) that of a complete thin spherical shell on an elastic foundation subjected to a unit normal load, and 2) that of a complete thin spherical shell on the same elastic foundation subjected to a unit tangential load. Serious shortcomings were uncovered in attempting to follow this solution formulation. They were due in part to an erroneous assumption of negligible relative magnitude of the meridional displacement, v, and also from convergence difficulties rendering numerical superposition of solutions untenable. A few formulations based on a solution in terms of Bessel's functions and Kelvin functions in the neighborhood of the load singularity was successfully applied to obtain numerical solutions for the two problems. The Kutta–Merson process of numerical integration is used to obtain complete numerical solutions, to which solutions are superimposed to match the appropriate boundary conditions. R.N.A.

N67-19104* General Dynamics/Convair, Huntsville, Ala.
STABILITY OF NONLINEAR VEHICLE SYSTEMS

L. L. Fontenot and E. L. Bernstein 12 Dec. 1966 360 p refs
(Contract NAS8-20270)
(NASA-CR-82667; GD/C-DDF-66-009) CFSTI: $3.00 CSCL 20K

Studies on the nonlinear effects of the motion of liquids in fixed and moving vessels on the stability and control of liquid-rocket powered missiles and space vehicles, are reported. A comprehensive analytical review of the state of the art concerning the stability of liquids in impermeable containers and the effect of the liquid motion on the stability of the containers (restrained and mobile) themselves, and a review of the state of the art of methods for determining the stability of vehicles undergoing axial acceleration, are presented. An example of the determination of fluid behavior in a container of unusual configuration is given along with a discussion of fluid behavior in parabolic containers undergoing vertical excitation. Equations of motion for liquids in elastic cylinders are developed and the importance of the effect of the coupling of fluid motion with the elastic vibrations of the container is emphasized. Geometric nonlinearity in the deformation of the container, considered as a thin shell of general shape, is considered. General equations for finite elastic deformations of shells partially filled with liquid undergoing large amplitude motion are developed for a general case. The influence of random longitudinal excitations on the response and stability of impermeable rigid tanks containing liquid is analyzed. The problem of the stability of a thin elastic plate under the action of non-deterministic loads is also examined. S.C.W.

N67-19106* Lockheed Missiles and Space Co., Huntsville, Ala. Research and Engineering Center.
VIBRATIONAL CHARACTERISTICS OF LARGE COMPLEX SPACE VEHICLES Final Report
W. D. Whetstone and M. L. Pearson 20 Dec. 1966 239 p refs
(Contract NAS8-20161)
(NASA-CR-82665; HREC-0161-1; LMSC/HREC-A783589) CFSTI: $3.00 CSCL 22D

Results are presented of an analytical study involving development of methods of analysis of the vibrational characteristics of a class of large, complex space vehicles. The method of analysis and computer program presented provide a practical and accurate means of calculating the lateral modes and frequencies of a broad class of non-symmetrical vehicles. An energy method of solution involving the solution of only relatively low-order eigenproblems is used, so that computer execution times are short. For example, many modes and frequencies of a typical Saturn V configuration may be computed in three or four minutes of IBM 7094 time, including the generation of an extensive set of SC-4020 plots of both the problem definition data and the vehicle mode shapes. The formulation upon which the program is based is presented in detail. A discussion of the computer program is presented, including a user's manual which provides a guide to the use of the program. A listing of the program, sample printed output, and solution data for a number of examples are included in the appendixes. Author

N67-19171 Lockheed Missiles and Space Co., Palo Alto, Calif.
AXISYMMETRIC STRAIN OF A RIB-REINFORCED CYLINDRICAL SHELL
P. A. Zhilin [1966] 5 p refs Transl. into ENGLISH from Mekh. Tverdogo Tel (USSR), no. 5, 1966 p 139–142

A cylindrical shell reinforced by ribs separated by an arbitrary spacing and with different geometric and elastic characteristics is considered. The solution is constructed on the basis of the Steklov–Fubini method. The equilibrium equations of a ribbed shell were obtained and are presented. The Steklov–Fubini agrees with the notation of V. V. Novozhilov. Author

N67-19175 Lockheed Missiles and Space Co., Palo Alto, Calif.
FREE AND PARAMETRIC VIBRATIONS OF AN INFINITE CYLINDRICAL SHELL IN AN ACOUSTIC MEDIUM
M. A. Il'gamov and A. Z. Kamalov [1966] 9 p refs Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved., Aviats. Tekh. (Kazan), no. 4, 1966 p 41–50

The combined vibrations of an elastic infinite cylindrical shell and subsonic ideal gas flow enclosed within the shell are considered. The affect of the external medium is not taken into account. The acoustic pressure and velocity field is determined taking account of interaction with the walls of the elastic shell. Questions of the vibrations of infinite shells in an ideal fluid have also been considered. The possibility of the manifestation of parametric vibrations in real structures subjected to internal pressure pulsations is mentioned. Author

N67-19191*# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Mulheim an der Ruhr (West Germany). Institut fuer Festigkeit.
ON THE DYNAMIC STABILITY BEHAVIOUR OF THIN ISOTROPIC CIRCULAR CYLINDRICAL SHELLS IN THE ELASTIC RANGE WITH TIME-DEPENDENT END-CONDITIONS. II: APPROXIMATIVE SOLUTIONS OF THE NONLINEAR EQUATIONS
Gertrud Kotowski Sep. 1966 104 p refs In GERMAN; ENGLISH summary
(DVL-556; DLR-FB-66-59) CFSTI: HC $3.00/MF $0.65

The problem described by coupled nonlinear partial differential equations is approximatively solved for two different approximative functions. After getting the coupled nonlinear ordinary differential equations for the time-dependent free parameters of the approximative functions, these equations are solved by an analog computer for a certain range of wave-numbers m (in axial direction) and n (in circumferential direction), and for several initial deformations. The applied axial end-load, respectively the applied axial end-displacement, are linear functions of time. For several cases the solutions of the quasistationary calculation, i.e. for vanishing acceleration, are determined. Comparing them with the dynamic solutions, the influence of the inertia term can be estimated. Author

N67-19195 Deutsche Forschungsanstalt für Luft- und Raumfahrt, Brunswick (West Germany). Institut fuer Flugzeugbau.
STABILITY OF THIN-WALLED OPEN PROFILES SUBJECTED TO CENTRICAL LOADING [STABILITAET DUENNWANDIGER OFFENER PROFILE BEI ZENTRISCHER BELASTUNG]
H.-E. Moritz Sep. 1966 83 p refs In GERMAN; ENGLISH summary
(DLR-FB-66-64) CFSTI: $3.00

For dimensioning of thin-walled bars with open cross-sections as compression members it is necessary to know their limits of stability. In compressed bars two different modes of instability generally occur: local buckling and column buckling. The determination of the critical loads corresponding to these modes requires much computation work. Therefore, diagrams in which the local buckling and column buckling factors are presented, are of great help for dimensioning. Such diagrams which allow the selections of optimum cross sections with respect to full utilisation of the material are compiled for the most usual profiles. Author

N67-19204*# Pittsburgh Univ., Pa. Dept. of Electrical Engineering.
THEORETICAL FOUNDATION OF SOME CRITERIA OF EQUILIBRIUM STABILITY OF PLATES [OBOSNOVANIE NEKOTORYKH KRITERIEV USTOICHIVOSTI RAVNOVESIIA PLASTIN]

A. A. Movchan 1 Jan. 1967 13 p refs Transl. into ENGLISH from Inzh. Zh. (Minsk), v. 5, no. 4, 1965 p 773–777
(Grant NGR-39-011-039)
(NASA-CR-82595) CFSTI: HC $3.00/MF $0.65 CSCL 20K

The problem of Lyapunov's stable equilibrium is formulated for orthotropic rectangular plates which are hinged over the contour and are compressed in two directions by constant loads. It is shown, that the stability criteria given for the problems considered follow from conditions in which the energy integral possesses the properties of a Lyapunov functional. The condition of positive definiteness of the energy integral is established by means of estimates related to the completeness of certain specified systems of functions. Author

N67-19241# Advisory Group for Aerospace Research and Development, Paris (France).
PREDICTING MATERIAL BEHAVIOUR UNDER LOAD, TIME AND TEMPERATURE CONDITIONS
H. P. van Leeuwen (Natl. Aero- and Astronautical Res. Inst.) Jun. 1965 231 p refs Presented at 20th Meeting of the AGARD Struct. and Mater. Panel, Munich, 9–15 Jun. 1965
(AGARD-513) CFSTI: HC $3.00/MF $0.65

Means are conceidered of accelerating mechanical tests on coupons, components, and structures with reference to engineering designs involving prolonged service at elevated temperatures. Basic problems concerning fatigue, creep, ageing and their interaction are discussed. Emphasis is put on their quantitative treatment. Conclusions are drawn and recommendations made. Author

N67-19277*# Martin Co., Baltimore, Md.
DEVELOPMENT OF TECHNIQUES AND FABRICATION OF A STRUCTURAL MODEL FOR RESEARCH ON STRUCTURES FOR HYPERSONIC AIRCRAFT Final Report, Jul. 1963–Jan. 1966
Richard A. Hirsch Jan. 1966 91 p refs
(Contract NAS1-3174)
(NASA-CR-66211) CFSTI: HC $3.00/MF $0.65 CSCL 01C

Techniques were developed and a structural model was fabricated to evaluate an evacuated, multiwall structure suitable for a hypersonic aircraft. Forming, welding, polishing, and brazing techniques are described along with fabrication of the model. Included are design principles, process developments, and fabrication procedures used for construction. It was concluded that this type of construction is not practical within the present state-of- the art. C.T.C.

N67-19315# Advisory Group for Aerospace Research and Development, Paris (France).
SELECTED PAPERS FROM AGARD STRUCTURES AND MATERIALS PANEL—NINETEENTH MEETING
Oct. 1964 86 p refs 19th Meeting of the Struct. and Mater. Panel of AGARD held in Paris, 12–17 Oct. 1964
(AGARD-511) CFSTI: HC $3.00/MF $0.65

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2. A NEW ITERATIVE APPROACH TO STRUCTURAL EIGENPROBLEMS I. Erdelyi and G. Occhini (GE) p 43–83 refs (See N67-19317 08-32)

N67-19316# Aerodynamische Versuchsanstalt, Gottingen (West Germany).
CALCULATION OF EIGENVALUES AND EIGENVECTORS OF LARGE NON-HERMITIAN AEROELASTIC MATRICES
Heinz Goellnitz, Hildegard Goellnitz, and Friedrich Wille *In* AGARD Selected Papers from AGARD Struct. and Mater. Panel—19th Meeting Oct. 1964 p 1–41 refs (See N67-19315 08-32) CFSTI: HC $3.00/MF $0.65

The iteration procedures of von Mises and of Wielandt for solving eigenvalue problems are applied successively to complex non-Hermitian matrices. Using a two-root procedure the course of calculation on an electronic computer is automatized and optimized so that all complex eigenvalues and eigenvectors of an aeroelastic matrix are obtained in a few seconds. Several numerical examples of matrices up to the 12th order are given to 8 figures, and examples of flutter calculations up to 12 degrees of freedom are given as diagrams. Author

N67-19317 General Electrico., Milan (Italy).
A NEW ITERATIVE APPROACH TO STRUCTURAL EIGENPROBLEMS
Ivan Erdelyi and Giulio Occhini *In* AGARD Selected Papers from AGARD Struct. and Mater. Panel—19th Meeting Oct. 1964 p 43–83 refs (See N67-19315 08-32) CFSTI: HC $3.00

A new numerical iterative algorithm suitable for the simultaneous determination of partial eigensystems of both real and complex matrices is described. The employment of this method into an automatic programming system for steady analysis of structures is being studied. Some numerical experiments on actual technical applications are given. Author

N67-19318* Barry Wright Corp., Watertown, Mass.
DAMPING OF STRUCTURAL COMPOSITES WITH VISCOELASTIC SHEAR-DAMPING MECHANISMS
Jerome E. Ruzicka, Thomas F. Derby, Dale W. Schubert, and Jerome S. Pepi
(Contract NAS1-5640)
(NASA-CR-742) CFSTI: HC $3.00 CSCL 20K

An investigation conducted to evaluate the so-called geometrical parameter of structural composites with viscoelastic shear-damping mechanisms is described. Design equations and graphs are developed for the geometrical parameter of a wide range of viscoelastic shear-damped structural composite designs. Using existing theory, manual and automated procedures are developed for the prediction of the structure loss factor of structural composites comprised of two elastic elements separated by a thin viscoelastic damping layer. Laboratory experiments are performed to verify the basic theory and design procedures developed. A comparison of theoretical predictions and experimental measurements of the structure loss factor is made for two-elastic-element structural composites fabricated from various combinations of structural materials including aluminum, steel and fiber-glass. Author

33 THERMODYNAMICS AND COMBUSTION

Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants.

N67-18215# Library of Congress, Washington, D. C. Aerospace Technology Div.
THE COMBUSTION OF MIXTURES CONTAINING POTASSIUM PERCHLORATE AS OXIDIZER AND METAL FUELS IN A VACUUM [O GORENII SOSTAVOV NA OSNOVE OKISLITELYA PERKHLORATA KALIYA I METALLICHESKIKH GORYUCHIKH V VAKUUME]
P. F. Pokhil and L. D. Romodanova 30 Aug. 1966 9 p refs Transl. into ENGLISH from Zh. Fiz. Khim. (Moscow), v. 39, no. 11, 1965 p 2757–2759
(ATD-66-76)

The combustion of mixtures containing potassium perchlorate and metallic fuels (tungsten, zirconium, and molybdenum) was studied in a vacuum to determine whether the initial combustion stage of the mixture took place in the condensed phase or the gaseous phase. Stoichiometric mixtures containing $KClO_4$ as the oxidizer and W, Zn, Mo, and Ti as fuels were used. Grains 5mm in diameter were compacted to the maximum density. Tabulated are results of the self-ignition temperatures of the mixtures in a vacuum and the sizes of the metal particles; surface temperatures of the mixtures during flameless combustion in a vacuum; results of the determined tungsten rate of flameless combustion of the mixtures; and results of the solid and gaseous phase analysis for flameless combustion in percentages of the initial batch. It was concluded that: (1) The initial stage of combustion of every mixture occurs in the reaction layer of the condensed phase, i.e., on the surface of the fuel particles, with a total positive heat of reaction, and ends in the generation of a smoke-gas combustible mixture which then burns in the region above the surface of the mixture until, under certain conditions, the final combustion products are formed; and (2) Self-ignition of the mixtures occurs at a temperature at which the metal is in the solid state. Author

N67-18276*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
STUDY OF THERMAL PROTECTION REQUIREMENTS FOR A LIFTING BODY ENTRY VEHICLE SUITABLE FOR NEAR-EARTH MISSIONS Final Report
M. J. Brunner, C. Dolan, R. Grasier, S. Kottock, and G. Merlo 12 May 1966 198 p refs
(Contract NAS2-2974)
(NASA-CR-73043; DOC.-66SD253) CFSTI: HC $3.00/MF $0.65 CSCL 20M

A study was made of the thermal protection requirements for the M2-F2 vehicle for a wide variety of vehicle sizes, weights, and reentry conditions. The effects of ascent and abort were included for the Titan II, Titan III-C, and Saturn I-B boosters. Heat protection requirements were established for systems which include ablation, re-radiation, and ablation over re-radiation, separately or in combination as required. Requirements were established for refurbishable systems having various materials and backface temperatures. Author

N67-18278*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
STUDY OF THERMAL PROTECTION REQUIREMENTS FOR A LIFTING BODY ENTRY VEHICLE SUITABLE FOR NEAR-EARTH MISSIONS Summary Report
M. J. Brunner 12 May 1966 16 p refs
(Contract NAS2-2974)
(NASA-CR-73042; DOC.-66SD255) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Accurate estimates of the weight of various thermal protection systems were obtained for a representative lifting body (NASA M2-F2) configuration capable of entry from a range of near earth orbits. Both ablative and combined ablative-re-radiation thermal protection systems with refurbishable capability were considered. In addition, the effect of problem areas associated with the design of efficient heat shields was determined and indications were made as to how the associated uncertainties could affect the weight estimates. Author

N67-18304*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
COMBINED RADIATION-CONDUCTION HEAT TRANSFER IN A FINNED CYLINDER IN SPACE
W. R. Bunton and E. M. Keberle *In its* Space Programs Sum. No. 37-42, Vol. IV 31 Dec. 1966 p 5–10 ref (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

The computation of the equilibrium temperature distributional function of a finned cylinder in the radiation field of the Sun is discussed. Considered are the following energy transfers at each infinitesimal surface element: (1) absorption and reflection of incident radiation from the Sun or other parts of the finned cylinder; (2) emittance of radiation according to the relationship $W=\sigma T^4$; and (3) conduction of heat inside the surface to neighboring surface elements. A system of equations were obtained for the three unknown functions: temperature T(x) and radiosities B(x) and C(x). Results were obtained by a particular variant of the successive approximation method. In the integral equation routine, a variable step-size Simpson rule was used; in the differential equation routine, a Runge–Kutta, Adams–Moulton package with automatic error control was used. It was found that convergence was increased time-wise: (1) when the differential equation routine was iterated more often than the integral equation routine; and (2) if the accuracy requirement for the boundary condition (T' condition) was not driven to an extreme. Graphical interpretations of results are also included. S.C.W.

N67-18327*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RESONANT COMBUSTION
J. G. Sotter and R. M. Clayton *In its* Space Programs Sum. No. 37-42, Vol. IV 31 Dec. 1966 p 88–105 refs (See N67-18301 08-34) CFSTI: HC $3.00/MF $0.65

In previous experiments with an engine using RMIR injector 5 with Corporal fuel and stabilized fuming nitric acid as propellants, the system was characterized by an oscillatory combustion mode exhibiting high amplitude shock like waves. These served as the basis for postulating the existence of a detonation-like wave front. Studies are described which were conducted to verify this postulate by extending measurements to determine the long time interaction of the wave on the injector, to verify certain predictable properties of the steady state combustion environment by experiment, to present some early results obtained in evaluating new diagnostic methods still in the developmental stage but expected to be suitable for the extremely severe environment produced by the wave, and to evaluate the effect of certain geometrical changes in the engine on the wave properties. R.N.A.

N67-18407*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EFFECT OF THERMOCOUPLE WIRE SIZE AND CONFIGURATION ON INTERNAL TEMPERATURE MEASUREMENTS IN A CHARRING ABLATOR
William D. Brewer Washington, NASA, Mar. 1967 35 p refs
(NASA-TN-D-3812) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Results are presented from an experimental investigation to determine the effect of thermocouple wire size and configuration on internal temperature measurements in a charring ablator subjected to a severe heating environment. The responses of thermocouples of various wire sizes with the lead wires parallel to the direction of heat flow and the responses of thermocouples with some length of the lead wires perpendicular to the direction of heat flow are compared with the responses of a reference thermocouple. The results show that, if the lead wires are parallel to the direction of heat flow, considerable heat is conducted away from the thermocouple junction and thus large errors occur in the temperature measurement. Heat losses due to conduction along the lead wires can be minimized by using thermocouples with lead wires perpendicular to the direction of heat flow. However, large errors in temperature measurements may also result from the uncertainties in the location of the thermocouple junction. For a given configuration, thermocouples made from the smallest wire produce the best results. Author

N67-18482# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

EXPERIMENTAL DETERMINATION OF HEAT EXCHANGE INTENSIFICATION IN A BIANGULAR CHANNEL WITH LOCAL EXPANSION OF THE CONDUIT CROSS SECTION

V. N. Orlov and A. S. Freydin *In its* Proc. of the Group Sci. and Tech. Conf. on Probl. of Fluid Mech. 13 Oct. 1966 p 1–13 refs (See N67-18481 08-12) CFSTI: HC $3.00/MF $0.65

Relinquishing the principle of "external floropast" in the biangular channels of a plate heat exchanger results in a rise of the ratio expressing the transferred heat to the hydraulic resistance; and the highest degree of heat exchange intensification was obtained with a form of local expansion. Local heat transfer of streamlined cylindrical bodies in an air stream was studied; and the heat flux on the surface was obtained by electrically heating a model of constant density, and four different geometrical shapes were used in a three-staggered section. In order to apply the measurement results to a biangular channel with a width-to-height ratio of cross section other than that of the tested channel, the experimental data were processed separately for each of the three channels. As the Reynold's number rises from 40,000 to 100,000, the degree of heat exchange intensification drops by 5 to 10%. M.W.R.

N67-18483# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

SOME RESULTS OF AN ANALYSIS OF EXPERIMENTAL DATA ON THE INTENSIFICATION OF HEAT EMISSION IN CHANNELS

A. S. Freydin and A. V. Yurin *In its* Proc. of the Group Sci. and Tech. Conf. on Probl. of Fluid Mech. 13 Oct. 1966 p 14–20 refs (See N67-18481 08-12) CFSTI: HC $3.00/MF $0.65

In order to obtain the turbulent Prandtl number dependence on some hydrodynamic flow characteristics, a fundamental formula was applied to a biangular channel with and without local expansions. The dependence established for the Prandtl number characterizes the isothermal motion of an incompressible liquid in a channel with variable conduit cross section. From results obtained with a flow under isothermal conditions, the heat transfer coefficients in channels of complex shapes can be found. Results are graphed for Prandtl numbers for various geometrical forms of local expansion and for different zones of the biangular cross section with three values of the Reynolds number. Velocity distributions are plotted in the cross section at 13,000 in a channel with different changeable sections. M.W.R.

N67-18484# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE CALCULATION OF THERMAL CHARACTERISTICS OF HEAT EXCHANGE DEVICES

G. M. Gorelov, V. N. Orlov, V. Ya. Reznik, and A. S. Freydin *In its* Proc. of the Group Sci. and Tech. Conf. on Probl. of Fluid Mech. 13 Oct. 1966 p 21–31 refs (See N67-18481 08-12) CFSTI: HC $3.00/MF $0.65

Simultaneous solution of the heat balance and heat transfer equations are required to calculate the thermal characteristics of heat exchangers. Since an immediate analytical solution is difficult, various approximations are employed. The dependence of the mean temperature drop is described for the cases of direct-flow and counterflow motions of the heat transfer agents; and for heat exchanger devices these flows are crossed and mixed. A nondimensional thermal characteristic is plotted for the both motions. Two examples are included. In one, air is moving with Prandtl number of 0.7 through the tubes of a smoothly tubular hear exchanger, and the thermal resistance is due to the air system of the heat exchanger. In the other example, a bundle of tubes is placed in an external gas flow, and the thermal resistance is due to the gas system. In both cases, dependences are determined by using expressions for Nusselt numbers. M.W.R.

N67-18488# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

APPLICATION OF ELECTROTHERMAL ANALOGY TO STUDY OF HEAT TRANSFER IN STREAMLINED BODIES OF ARBITRARY SHAPE

A. V. Temnikov and Ye. V. Shchibrayev *In its* Proc. of the Group Sci. and Tech. Conf. on Probl. of Fluid Mech. 13 Oct. 1966 p 60–70 refs (See N67-18481 08-12) CFSTI: HC $3.00/MF $0.65

A method suggested for determining local coefficients of heat transfer by means of an electrothermal analogy permits electrical simulation without an analytical solution to the problem. The method does not require a laborious harmonic analysis to find the heat transfer coefficient, nor does it require mapping. It is applicable to investigations of three-dimensional bodies of arbitrary shape, and can be extended to the nonsteady problem. M.W.R.

N67-18553 Lockheed Missiles and Space Co., Palo Alto, Calif.

CYLINDRICAL CONDUCTOR HEATED BY A CURRENT

A. V. Pustogarov [1965] 3 p refs Transl. into ENGLISH from Inzh.-Fiz. Zh. (Moscow), v. 11, no. 5, 1966 p 662–663

The radial temperature distribution and current density in an infinite cylindrical conductor are examined taking into account the temperature dependence of heat and electrical conduction coefficients. An approximate method of solution is considered for a case involving a conductor heated by direct current. It follows from the analysis conducted that for given temperatures on the axis and on the conductor surface the electric power to be consumed is independent of the conductor radius. Therefore, constancy of the temperature profile over the relative radius can be conserved. A.G.O.

N67-18570# Naval Civil Engineering Lab., Port Hueneme, Calif.

THE SOLUTIONS TO TWO PROBLEMS IN HEAT TRANSFER

W. L. Wilcoxson *In its* Cooling Analysis for Protective Struct. Located Above and Below Ground Nov. 1966 p 37–76 refs (See N67-18569 08-11) CFSTI: HC $3.00/MF $0.65

Mathematics are given for determining the heat transferred from air at a constant temperature to a semi-infinite solid, as well as for a constant heat transferred from air through a solid slab to a semi-infinite solid. The physical models are shown for both problems, and temperature distribution within the solid and the rate of heat per unit area are determined for the first problem. For the second problem, it is assumed that the solids and the air are at some starting equilibrium temperature; and equations are evolved for determining the air temperature at the air-slab interface, and the temperature distribution within the solids. M.W.R.

N67-18672 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.

EXPOSITION OF THE COMBUSTION IN SUPERSONIC FLOWS [EXPOSE SUR LA COMBUSTION DANS LES ECOULEMENTS SUPERSONIQUES]

L. Viaud *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 19–20 (See N67-18661 08-34) CFSTI: $3.00

Of interest to hypersonic aircraft research, studies on flame stability, and propellant combustion in supersonic flow are reported. Thermodynamic action, together with physical and chemical mixing, and constant pressure considerations are also briefly mentioned. Two methods are given to ensure flame combustion; but attention is focused upon injection combustion in high temperature flow conditions, using kerosene or hydrogen. Stable combustion simulation is reported at Mach 11 and 49 km altitude, and at Mach 6.6 at 25 km. Transl. by R.U.

N67-18684 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.

THERMAL LAYER LIMITS AND HEAT TRANSFER AT HYPERSONIC SPEEDS [COUCHES LIMITE THERMIQUES ET TRANSFERT DE CHALEUR EN HYPERSONIQUE]

R. Michel *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 39–40 (See N67-18661 08-34) CFSTI: $3.00

Thermal phenomena, and heat transfer both at the wall of space vehicles and on the forebody of missiles, are some of the topics summarized in this conference paper. An integral method based on global energy equations is emphasized for the study of both the laminar and the turbulent boundary layers; this method facilitates the determination of heat transfer on the leading edge of a wing, taking the pressure gradient into account. Analytical results, on heat flux at the wall, enthalpy distribution, and concentration in the boundary layer, show the influence of the catalytic power of the wall participating in the reaction. Transl. by R.Li.

N67-18779# Brookhaven National Lab., Upton, N. Y.

HIGH-TEMPERATURE LIQUID-METAL TECHNOLOGY REVIEW Bimonthly Technical Progress Review

Apr. 1966 58 p refs *Its* Vol. 4, No. 2

(Contract AT(30-2)-GEN-16)

(BNL-991) CFSTI: HC $3.00/MF $0.65

Information is summarized on progress in the categories physical properties and thermodynamics, fluid dynamics, heat transfer, materials development and corrosion, instrumentation, component development, systems studies, chemistry and chemical analysis, and fabrication techniques. NSA

N67-18898# Atomics International, Canoga Park, Calif.

FREE CONVECTION OF A SODIUM–POTASSIUM EUTECTIC IN AN ENCLOSED SPACE BETWEEN TWO VERTICAL PLATES WITH UNIFORM HEAT FLUX

A. F. Lillie 25 Oct. 1966 77 p refs

(Contract AT(11-1)-GEN-8)

(NAA-SR-12004) CFSTI: HC $3.00/MF $0.65

An experimental investigation was conducted of laminar steady-state free convection in an enclosed space between parallel vertical walls with uniform heat flux. Major interest centered on the use of sodium–potassium eutectic (NaK) liquid metal heat transfer medium. Helium and an oil-like fluid (HB-40) were also employed to provide validation of the NaK results. Heat fluxes of 9,660 to 45,500 Btu/Hr-ft^2 were achieved in the NaK runs. Longitudinal temperature profiles were measured for both the hot and cold heat transfer plates using stainless steel sheathed chromel–alumel type thermocouples. The applied heat flux and the separation distance between the plates were experimental variables. The experimental results indicate that the Krausold plot, which is a measure of the influence of free convection on the heat flow across plane fluid layers, is valid for liquid metals. From a design standpoint, the Krausold plot is inconvenient for the case of uniform heat flux since it was devised for the isothermal wall condition. For this reason, a modified Krausold plot was generated from the data obtained. The modified plot uses those terms known by the designer when starting a calculation to determine the influence of free convection on the net heat flow across plane fluid layers under uniform heat flux conditions. As a first approximation, the modified plot could be extended to other geometries and fluid layer orientations. Qualitative observations made during the course of the investigation showed the existence of an instability situation when conditions of the plate spacings and impressed heat fluxes were appropriate. The instability, postulated to be the result of small convection vortex cells, causes erratic temperature readings but does not appear to grossly affect the net heat transfer characteristics of the system. The experimental results were compared to the analytical predictions determined from the theory as given by Sparrow and Gregg for laminar steady-state free convection on a vertical wall with uniform heat flux. The results indicate that the local heat transfer coefficients agreed within ±30% even though a basic boundary condition used in the theory was violated. On the cold plate, where the uniform heat flux condition was not met, the agreement was less satisfactory (±50%). Average heat transfer coefficients agreed within ±20% for the uniform heat flux condition. Author (NSA)

N67-18879*# Southern Methodist Univ., Dallas, Tex.

HEAT TRANSFER ACROSS SURFACES IN CONTACT: PRACTICAL EFFECTS OF TRANSIENT TEMPERATURE AND PRESSURE ENVIRONMENTS Semiannual Report, 1 Apr.–1 Oct. 1966

Harold A. Blum 1 Oct. 1966 15 p ref

(Grant NsG-711)

(NASA-CR-82396) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Continuing research in one-dimensional transient experiments is discussed, and modification of the apparatus to prevent time consuming calibrations is mentioned. Results indicated that the transient behavior of two-layer composite metals with contact resistance can be predicted from simple theoretical solutions with sufficient accuracy. Theoretical studies of two-dimensional heat transfer across surfaces in contact are also discussed, with emphasis placed on systems in contact with a common sink. A two-dimensional steady-state solution was developed and showed that as time increased in the transient solution the temperature distribution matched the steady-state solution. A passive control device in which contact conductance plays a part is mentioned, and it was pointed out that the control portion of the system is simple and would be inexpensive to fabricate. Finally, the construction of an apparatus to obtain more accurate values for contact conductance coefficients is briefly reported. L.E.W.

N67-18980*# Southern Methodist Univ., Dallas, Tex.

AN INVESTIGATION OF THE BEHAVIOR OF A PASSIVE HEAT TRANSFER CONTROL DEVICE

Frank A. Fitz [1966] 16 p ref

(Grant NsG-711)

(NASA-CR-82395) CFSTI: HC $3.00/MF $0.65 CSCL 20M

The problem of maintaining a predetermined temperature in the near vicinity of a variable source of thermal energy is considered in relation to a passive heat transfer control device. The apparatus is described, as well as the method of investigation, analytical results, and experimental results. It was concluded that the average temperature at which a device of this type will control can be predicted with accuracy, and the device will control temperature within a reasonable range of power inputs. The thermal conductance behavior of the conical washer appears to be ideal for this application with the exception of the relatively high initial leakage through the circular contact points. Additional investigation was recommended to determine the control's upper limits and its feasibility as a small package without framework, dependent on the difference in thermal expansion of two metals. L.E.W.

N67-19015 Los Alamos Scientific Lab., N. Mex.

HEAT PIPE CAPABILITY EXPERIMENTS

J. E. Kemme 27 Oct. 1966 42 p refs

(Contract W-7405-ENG-36)

(LA-3585-MS) CFSTI: HC $3.00/MF $0.65

Axial heat transfer limits were determined for several heat pipe systems having the same outside dimensions, but different wick configurations. Measurements were made at temperatures from 450 to 850°C by using potassium and sodium as working fluids. The wicks consisted of many axial channels, evenly spaced around the inside circumference of each container tube. Different size channels were studied and, in some tests, a layer of fine screen was used to cover the channels and separate them from the vapor passage. The experiments were chosen to show some possible methods for wick improvement and to check the validity of existing

heat pipe equations. At higher test temperatures, good agreement was obtained between measured and calculated heat transfer limits. At low temperatures, however, heat transfer capability was below that predicted by theory, and startup difficulties were encountered with the open-channel systems. These problems appear due to an interaction between low-density, high-velocity vapor and returning liquid. The screen covering helped startup and substantially increased heat transfer capability at all operating temperatures. Author (NSA)

N67-19030*# Southern Methodist Univ., Dallas, Tex.
THE THERMAL CONDUCTIVITIES OF SEVERAL METALS: AN EVALUATION OF A METHOD EMPLOYED BY THE NATIONAL BUREAU OF STANDARDS
David Roth Williams (M.S. Thesis) 15 Nov. 1966 182 p refs
(Grant NsG-711)
(NASA-CR-82479) CFSTI: HC $3.00/MF $0.65 CSCL 20M

The method, involving two experiments, gives two equations wherein thermal conductivity and heat loss are functions of measured temperatures. Simultaneous solution provides the thermal conductivity. An Armco iron specimen of known thermal conductivity is used to calibrate the apparatus for heat losses. This calibration affords a comparative method for determining thermal conductivities in one experiment. A second absolute method is devised in which heat losses are made negligible. This method also allows thermal conductivities to be found in a single experiment. Armco iron, 2024-T351 aluminum, AISI 303MA and AISI 316 stainless steels are tested. Comparisons show the N.B.S. absolute method is accurate within four percent; the comparative method is accurate within ten percent; and the negligible loss absolute method is accurate within two percent. Author

N67-19138*# Cornell Univ., New York.
SELF PRESSURIZATION OF LIQUID HYDROGEN TANKAGE
John Charles Aydelott (M.S. Thesis) Feb. 1967 69 p refs
(NASA-CR-82459) CFSTI: HC $3.00/MF $0.65 CSCL 20M

A nonventing 9-inch-diameter spherical Dewar partially filled with liquid hydrogen was subjected to twenty-one quiescent self pressurization tests. The Dewar was subjected to various combinations of the variables percent filling, heat transfer rate, and either top heating only, bottom heating only, or uniform heating. The rate of pressure rise in the Dewar was found to be primarily a function of the heating configuration with the percent filling and heat transfer rate playing a secondary role. Appreciable energy transfer from the vapor to the liquid causing evaporation and liquid heating occurred during both the uniform heating and top heating only tests. Author

N67-19168 Lockheed Missiles and Space Co., Palo Alto, Calif.
ANALYSIS AND SOLUTION OF THE VOLUME PROBLEM OF RADIATION TRANSFER AND RADIANT HEAT EXCHANGE IN RADIATING SYSTEMS OF DIFFERENT CONFIGURATIONS (SPHERE, CYLINDER)
Iu. A. Surinov and V. M. Melent'ev [1966] 20 p refs Transl. into ENGLISH from Russian

A stationary mixed problem of radiation transfer and radiant heat exchange within a sphere filled with a diathermal medium, whose surface consists of three homogeneous and isothermal grey domains (F_1, F_2, F_3) with temperatures T_1, T_2, T_3 and optical characteristics A_1, A_2, A_3 is solved for various aspects of the problem (domain temperatures, and radiation coefficients at various points of the radiation field). A fundamental formulation of the stationary problem of radiation transfer and radiant heat exchange is also considered for a spherical cavity with an optically homogeneous and isothermal grey surface F_1 filled with a diathermal medium. The values of the densities of the different kinds of radiation at both the boundary and interior points of the radiation field generated by the cavity, by means of given values of the temperature, optical constants on the surface F_1, and the degree of opening of the cavity, are determined. In addition, the stationary mixed problem was also considered for a cylindrical chamber with grey isothermal homogeneous bases F_1 and F_3, and a side surface (lining) F_2 filled with a diathermal medium. L.S.

N67-19196# European Atomic Energy Community, Ispra (Italy). Engineering Dept.
TEMPERATURE FLUCTUATIONS IN THE HEATING WALL AND IN THE BOILING LIQUID DURING NUCLEATE BOILING
C. Bonnet, E. Macke, R. Morin, and J. Salomon Brussels, EURATOM, Nov. 1966 102 p refs In FRENCH; ENGLISH summary
(EUR-3162.F) CFSTI: HC $3.00/MF $0.65

The nucleation phenomenon in boiling is accompanied by temperature fluctuations both in the heating wall and in the boiling liquid. In the experiments reported here it was possible to directly relate the temperature transients to the bubble history. This method is claimed to give a better understanding of the mechanisms involved. Theoretical models of bubble formation are proposed which satisfactorily agree with the experimental results. Also information on microturbulence is drawn from the fluid temperature transients between the nucleation sites. Author

N67-19199# Israel Inst. of Tech., Haifa. Dept. of Aeronautical Engineering.
EXPERIMENTAL INVESTIGATION OF TURBULENT SWIRLING FLAMES
A. Chervinsky and Y. M. Timnat Sep. 1966 32 p refs
(TAE-56) CFSTI: HC $3.00/MF $0.65

By introducing swirl into flames an adverse pressure field is set up. This pressure field changes the velocity distribution at the burner exit and causes a faster decay of the axial velocity in comparison to a non-swirling flame. Measurements of velocity and temperature were carried out in swirling butane-propane air flames, which emerged from a round orifice with exit velocities of 75 to 100 m/sec. The flame was unconfined over a distance of 2 meters where the measurements were taken. Due to a faster decay of the velocity and more favorable conditions at the exit, flames with swirl can be stabilized closer to the burner exit at higher values of maximum velocity. The length of the flame decreases markedly with increasing degree of swirl. A certain increase in the temperature maximum with the degree of swirl is also observed. Isotherms of the flame, which show the variation in its shape with the degree of swirl, are presented graphically for 3 different cases. The results obtained indicate that the use of swirl in flames can lead to better performance of combustion chambers and industrial furnaces. Author

N67-19203 Bureau of Mines, Amarillo, Tex.
ZERO PRESSURE THERMODYNAMIC PROPERTIES OF NITROGEN GAS
Robert E. Barieau and Philip C. Tully 1967 52 p refs
(BM-IC-8319)

The following zero pressure thermodynamic properties of nitrogen gas are tabulated: C_p, $H^\circ - H_o$, S°, $H^\circ - H_o/T$, $G^\circ - H_o/T$. These properties are tabulated in units of joules, gram-mole, degrees Kelvin and in calories, gram-mole, degrees Kelvin for every degree Kelvin from 50° to 550°. The same functions are also tabulated in units of British thermal units, pound-mole, degrees Rankine for every degree Rankine from 100° to 1,000°. Author

N67-19219# Bureau of Mines, Amarillo, Tex.
THERMOPHYSICAL PROPERTIES OF SELECTED GASES BELOW 300°K

Ross A. Guereca, H. P. Richardson, J. L. Gordon, J. D. Walker, and J. L. Cooper [1967] 214 p refs
(BM-IC-8317) CFSTI: HC $3.00/MF $0.65

Results of a literature search on the general and specific physical properties of 16 gases are presented. The gases include helium, helium 3, neon, argon, krypton, xenon, radon, hydrogen, deuterium, nitrogen, oxygen, carbon monoxide, carbon dioxide, methane, ethane, and air. Data on specific properties include viscosity, thermal conductivity, specific heat, compressibility, vapor pressure, density, dielectric constant, and refractive index. The data are presented in tables and graphs. The data in the tables were chosen for exact representation and comparison of specific values. An attempt was made to select the most reliable and consistent value available for a given property without extensively analyzing each source reference. The graphs show trends and anomalies which may be obscure in tabular form. The methods used in evaluating the data are discussed. R.N.A.

N67-19227# Naval Research Lab., Washington, D. C.
FLAMMABILITY IN UNUSUAL ATMOSPHERES. PART 1: PRELIMINARY STUDIES OF MATERIALS HYPERBARIC ATMOSPHERES CONTAINING OXYGEN, NITROGEN, AND/OR HELIUM
J. E. Johnson and F. J. Woods 31 Oct. 1966 28 p refs
(NRL-6470, Pt. 1; AD-644556) CFSTI: HC $3.00/MF $0.65

A study of the flammability of fabrics and other solids under unusual atmospheric conditions was initiated. The most profound effect on both ease of ignition and linear burning rate was caused by oxygen enrichment. For example, many materials which did not ignite in 21% oxygen ignited and burned readily at 31% or 41% oxygen. With a given atmosphere, increase in pressure was often effective in causing ignition where no ignition occurred at lower pressures. Substitution of helium for nitrogen in mixtures with oxygen had two generally significant effects. Helium decreased the tendency of a material to ignite. This effect was shown to be due largely to the high thermal conductivity of helium. Once ignited, burning rates were often much faster in helium than nitrogen. Author (TAB)

N67-19298# Minnesota Univ., Minneapolis. Dept. of Mechanical Engineering.
HEAT AND MASS EXCHANGE IN THE SUPERSONIC BASE REGION
C. J. Scott and E. R. G. Eckert *In* AGARD Separated Flows, Pt. I May 1966 p 429–478 refs (See N67-19281 08-12)
CFSTI: HC $3.00/MF $0.65

The proposed model states that the turbulent mixing layer does not significantly affect the wall heat transfer, but merely reacts to it. The dominant phenomenon governing the heat exchange process is traced to a thin boundary layer adjacent to the wall. Turbulent mixing layer solutions are presented involving parametric variations of Mach number, recirculation zone temperature, and turbulent analysis by requiring that the predicted adiabatic recirculating zone temperatures agree with experimental results. The model selected for the wall film is a conventional, laminar stagnation point flow. This assumption excludes rearward steps from this analysis. The two analyses are combined by equating surface heat and mass transfer rates (the analysis also includes distributed wall mass transfer). Recirculation zone-wall temperature differences are computed which compare favorably with experiments. Author

N67-19320* Heat Technology Lab., Inc., Huntsville, Ala.
HEAT TRANSFER AND ABLATION RATE MEASUREMENT IN SATURN S-II ULLAGE MOTOR EXHAUST PLUME Final Report
22 Jul. 1966 32 p ref
(Contract NAS8-11850)
(NASA-CR-62650; HTL-TR-31) CFSTI: HC $3.00 CSCL 20M

One heat transfer and one ablation rate probe were used to measure stagnation heating rates and ablation rates in the exhaust plume of an S-II ullage motor. Data from the heat transfer probe indicated that the stagnation heating rate reached 3000 Btu/ft^2 sec in approximately 0.4 seconds, remained constant until approximately 0.8 seconds, and slowly increased to 3700 Btu/ft^2 sec by the end of the 4.2 second test. Ablation depth data from the ablation rate probe substantiated these measurements by closely following the theoretically predicted ablation depths for the heating rates measured by the heat transfer probe. Author

34 GENERAL

Includes reports of a broad nature related to industrial applications and technology, and to basic research; defense aspects; law and related legal matters; and legislative hearings and documents.

N67-18222# Brown, Boveri und Cie, A. G., Heidelberg (West Germany).
EUROPEAN SPACE-POWER PROSPECTS—AN AMERICAN'S IMPRESSION
N. Rasor *In* WGLR Rept. on the Meeting of the WGLR Comm. on Nucl. Energy in Aerotechnol., 8–9 Dec. in Stuttgart Jun. 1966 p 7–8 (See N67-18221 08-22) CFSTI: HC $3.00/MF $0.65

Middle-range electric space-power plants stand out as an exceptional opportunity for Europe compared with other important aspects of space technology and show a good potential for early economic return. The power range to aim for falls between the reasonable extension of existing space-power systems, and realistic estimates of the highest powers needed within the next ten to fifteen years. The comparitively rapid emergence of static nuclear power plant technology in the past few years makes this approach especially attractive. Author

N67-18252*# Chicago Univ., Ill. Graduate School of Business.
AN ENTREPRENEURIAL THEORY OF FORMAL ORGANIZATIONS. PART I: PATTERNS OF FORMAL ORGANIZATIONS
Selwyn W. Becker and Gerald Gordon [1966] 53 p refs
(Grant NsG-370)
(NASA-CR-71866) CFSTI: HC $3.00/MF $0.65 CSCL 05J

A theory of formal organizations is presented which includes, as a first step, the development of a taxonomy which allows an ordering of relevant data. This taxonomy is based on two variables, the nature of organizational procedures and the nature of the organization's resources. Classifying organizations by these two variables yields information about bureaucratic structures and about the manner in which authority is exercised in these structures. Further, use of the taxonomy allows inferences to be made about the environmental conditions associated with the emergence of the various bureaucratic structures. A formal organization is defined to be a purposely developed system, i.e., an ongoing interaction of procedures and resources to which an owner has property rights. It is assumed that the reason an owner seeks to attain his goal by creating (using, buying, renting, etc.) an organization is to obtain the economic or psychological advantages that result from coordination. C.T.C.

N67-18263 Joint Publications Research Service, Washington, D. C.
TRANSLATIONS ON COMMUNIST CHINA: SCIENCE AND TECHNOLOGY, NO. 360

4 Jan. 1967 25 p refs Transl. into ENGLISH from Chinese (JPRS-39414; TT-67-30064) CFSTI: $3.00

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1. SPACE-TIME CORRELATION FUNCTION OF SCATTERED FIELDS K.-c. Liu p 1–18 refs (See N67-18264 08-07)

2. CHINA'S FIRST ADVANCED PLANT MAKING SULPHURIC ACID FROM WASTE GAS p 19–21

N67-18301*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACE PROGRAMS SUMMARY NO. 37–42, VOLUME IV FOR THE PERIOD OCTOBER 1, 1966 TO NOVEMBER 30, 1966. SUPPORTING RESEARCH AND ADVANCED DEVELOPMENT
31 Dec. 1966 312 p refs
(Contract NAS7-100)
(NASA-CR-81966; JPL-SPS-37-42, Vol. IV) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Articles on scientific programming, systems analysis, guidance and control, engineering mechanics, propulsion, space sciences, and telecommunications are presented. For individual titles see N67-18302–N67-18351.

N67-18364# European Space Research Organization, Paris (France).
GENERAL REPORT, 1964–1965
1966 161 p refs
CFSTI: HC $3.00/MF $0.65

This document outlines the history of the Organization and the progress achieved in the work and experiments carried out during the first two years of its existence, and gives a summary of the 8-year program and budget. ESRO

N67-18369# Southampton Univ. (England). Inst. of Sound and Vibration Research
THE CONSTRAINING ORDER OF AIRPORT NOISE
E. J. Richards Jul. 1966 50 p refs
(ISAV-148) CFSTI: HC $3.00/MF $0.65

Presents a method of assessment of noise nuisance around airports based on the concept of total weighted acoustical energy received per day by any member of the community, and establishes an index of community noise (I.C.N.) which is not dependent upon details of each flight plan. The method is used to indicate the likely growth of nuisance at airports during the next twenty years, and discusses the particular problems of the supersonic transport. It is shown that the transfer to jet travel at an airport is equivalent to a 4 PNdB growth in I.C.N., and that the general growth of traffic will increase I.C.N. by 3 PNdB every five years. There is need, therefore, for an equivalent reduction in the noise of individual aircraft of 10 PNdB to keep nuisance at the same level for the next ten years. Methods of achieving this are discussed. Author (ESRO)

N67-18370# Royal Observatory, Edinburgh (Scotland). Satellite Tracking Section.
COORDINATES FOR INSTRUMENTS AT EARLYBURN OUTSTATION
Bennet McInnes 28 Oct. 1966 5 p
(Rept.-59) CFSTI: HC $3.00/MF $0.65

Coordinates for instruments at Earlyburn Outstation, which comprises also Earlycoast, Earlyfix and Earlypoint positions, are given. Earlyburn has been housing a cinetheodolite since 1961; at Earlycoast the Wild BC-4 camera was mounted early in 1966; Earlyfix is for use as a trigonometrical station and at Earlypoint a Hewitt camera was set up in July 1966. The geodetic coordinates of the four marks and heights of the marks and the appropriate points in the instruments are listed. ESRO

N67-18376 Hamburgisches Welt-Wirtschafts-Archiv (West Germany).
LEGAL AND POLITICAL IMPLICATIONS OF SPACE RESEARCH Bibliography
H. Peter Kehrberger, comp. Verlag Weltarchiv GmbH, 1965 432 p refs

A selective bibliography of Eastern and Western Hemispheric sources concerning the legal and political implications of space research is presented. The material relates to space law and its background; and political, military, and economical aspects and technological-scientific problems of astronautics. Documents and activities of states and international organizations are referred to. L.S.

N67-18378 International Astronautical Federation, Paris (France). International Inst. of Space Law.
WORLDWIDE BIBLIOGRAPHY FOR THE YEAR 1964 OF SPACE LAW AND RELATED MATTERS [BIBLIOGRAPHIE MONDIALE POUR L'ANNEE 1964 DE DROIT SPATIALE ET MATIERES CONNEXES]
Aug. 1965 43 p refs In FRENCH and ENGLISH
(IISL-BIBL.-1) Available from Inter. Astronautical Federation, Paris: $3.00

References to books and articles of periodicals, published in Argentina, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, West Germany, Greece, Hungary, India, Italy, Japan, Netherlands, Norway, Poland, Rumania, Spain, Switzerland, Czechoslovakia, Turkey, UK, USA, Uruguay, USSR, Venezuela, Yugoslavia, are contained in this bibliography. They refer to organs dealing with space law, outline the progress in the conquest of space, the development and general principles of space law and relate to different activities and uses of space as well as to military problems. ESRO

N67-18454# American Univ., Washington, D. C. Center for Research in Social Systems.
SOCIAL SCIENCES INFORMATION SYSTEMS WORKSHOP PROCEEDINGS
Hans C. Ullmann and Victor F. Shaukias, ed. Nov. 1966 105 p refs Proc. held at Airlie Foundation, Warrenton, Virginia, 8–11 May 1966 Co-sponsored by System Develop. Corp.
(Contract DA-49-092-ARO-7)
(AD-643990) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. THE SOCIAL SCIENCES AND INFORMATION SYSTEMS L. F. Carter (Sys. Develop. Corp.) p 9–21 refs (See N67-18455 08-34)

2. OPERATIONS ANALYSIS GROUP R. Boguslaw and J. L. Morey p 25–30 (See N67-18456 08-34)

3. INFORMATION TECHNOLOGY AND AUTOMATION GROUP J. W. Singleton and M. H. Goer p 31–34 (See N67-18457 08-34)

4. INFORMATION SYSTEM OPERATION GROUP B. K. Dennis and F. N. White, Jr. p 35–43 ref (See N67-18458 08-34)

5. CINFAC'S INFORMATION SYSTEM R. H. Moore p 44–53 (See N67-18459 08-34)

6. CLOSING REMARKS AND SUMMARY Raymond P. Barrett and James W. Singleton p 57–115 refs

N67-18455# System Development Corp., Falls Church, Va.
KEYNOTE ADDRESS: THE SOCIAL SCIENCES AND INFORMATION SYSTEMS
Launor F. Carter *In* Am. Univ. Social Sci. Inform. Systems Workshop Proc. Nov. 1966 p 9–21 refs (See N67-18454 08-34) CFSTI: HC $3.00/MF $0.65

Some common problems inherent in the application of empirical and information data base systems in the social sciences are discussed in non-technical terms. The scope extends from the practical use from the solution of complex mathematical and physically formulated problems to batch processing, repetitive-operation jobs, such as payroll and insurance policy accounts. This keynote address ends with observations on the planning and support of social science research. R.Ll.

N67-18456# American Univ., Washington, D. C. Center for Research in Social Systems.
OPERATIONS ANALYSIS GROUP
Robert Boguslaw and James L. Morey *In its* Social Sci. Inform. Systems Workshop Proc. Nov. 1966 p 25–30 (See N67-18454 08-34) CFSTI: HC $3.00/MF $0.65

Attempts are reported to assess the present status of information retrieval systems in relation to the social sciences. Application was to the following topics: urban development, arms control, decision making needs, administrative management and economic aid programs in foreign countries, forecasting political and social trends in foreign countries, and the establishment of insurgency movements. A brief description of a prototype information system model is given. It specifies sequentially a collection reporting, and indexing and abstracting process leading into a data base which could be queried by the user. A preliminary analysis was made of the information retrieved before dissemination. Provision was also made for feedback from the user. R.Ll.

N67-18457# American Univ., Washington, D. C. Center for Research in Social Systems.
INFORMATION TECHNOLOGY AND AUTOMATION GROUP
James W. Singleton and Marvin H. Goer *In its* Social Sci. Inform. Systems Workshop Proc. Nov. 1966 p 31–34 (See N67-18454 08-34) CFSTI: HC $3.00/MF $0.65

Summary data are presented on the working group on Information Retrieval and Automation in relation to social science research. Group subject matter interest covered the following topics: historical data, legal case reports, biomedicine, industrial research, counter insurgency, market research, foreign agreements, management and program control information, and socioeconomic data on education, transportation, urban planning, employment and waste management. It was recommended that greater publicity should be given to the existing social science data sources and systems, and suggested that the role of government be expanded in this area. R.Ll.

N67-18458# American Univ., Washington, D. C. Center for Research in Social Systems.
INFORMATION SYSTEM OPERATION GROUP
Bernard K. Dennis and Frederick N. White, Jr. *In its* Social Sci. Inform. Systems Workshop Proc. Nov. 1966 p 35–43 ref (See N67-18454 08-34) CFSTI: HC $3.00/MF $0.65

A conference workshop gaming approach to two real-life information system situations was tested in consideration of current and potential problems and possibilities for mechanization of social science information. Broad categories of interests were represented for information systems primarily in the physical sciences and engineering fields. The need was cited for increased coordination among information activities in the social sciences, the information systems for which lag behind the systems operative for the physical science and engineering fields. While discussing the cost effectiveness of information retrieval, it was considered that most present systems are too small to economically justify mechanization by computer. Group analysis of the information scientist concept appeared to indicate some doubt as to whether individuals could become adequately qualified in all necessary areas to fulfill the role as stated, effectively and in depth. R.Ll.

N67-18459# American Univ., Washington, D. C. Center for Research in Social Systems.
CINFAC's INFORMATION SYSTEM
Richard H. Moore *In its* Social Sci. Inform. Systems Workshop Proc. Nov. 1966 p 44–53 (See N67-18454 08-34) CFSTI: HC $3.00/MF $0.65

Counterinsurgency movements, essentially political in nature, are dealt with in a study of the concept of an information analysis system co-sponsored jointly by the American University and the System Development Corporation. The Counterinsurgency Information Analysis Center (CINFAC) is preparing a file of expert consultants, analyzing bibliographic services available to customers, and assessing the need for a periodic review reflecting the state of both research and operations in the general field of insurgency and counterinsurgency. A general outline is presented as background for this social information system which includes every type of information that SORO deals with: the people, their working and living habits, their attitudes, their ambitions, and many more environmental factors. It is considered that a major problem in providing real assistance to outside users of the center is that of proper identification of the customer's actual information requirements. It is also considered that any system for processing information must possess inherent flexibility in order that it may adapt to the needs of a growing clientele rather than forcing the clientele to conform to the requirements of a stylized system. R.Ll.

N67-18511 Joint Publications Research Service, Washington, D. C.
TRANSLATIONS ON COMMUNIST CHINA'S SCIENCE AND TECHNOLOGY, NO. 358
20 Dec. 1966 60 p refs Transl. into ENGLISH from Shang-Hsueh Hsueh-Pao (Peking), v. 3, no. 1, 7 Mar. 1966 p 1–7, 14–28, 34–39, 45–46
(JPRS-39185; TT-66-35607) CFSTI: $3.00

CONTENTS:

1. THE THEORY AND MEASUREMENT OF AN ELECTROMAGNETIC IMPULSE SOUND-SOURCE C.-k. Liu, S.-y. Cheng, and H.-l. Ling p 1–15 refs (See N67-18512 08-23)
2. EXPERIMENTAL HIGH-SPEED PHOTOGRAPHIC INVESTIGATION OF THE MOTION OF A SINGLE CAVITATION BUBBLE T.-c. Chang and C.-h. Wang p 16–28 refs (See N67-18513 08-12)
3. ON THE RANDOM VIBRATION OF ELASTIC PLATE T.-y. Huang p 29–41 refs (See N67-18514 08-32)
4. SPACE-TIME CORRELATION FUNCTION OF A NOISE-FIELD C.-y. Hsu p 42–54 refs (See N67-18515 08-23)
5. THE DEVELOPMENT OF A SOUND SPECTROGRAM P.-k. Fan p 55–58 ref (See N67-18516 08-07)
6. SYMPOSIUM ON THE NOISE OF GEARS Hsu-ya Huang p 59–60
7. THE FIFTH INTERNATIONAL SYMPOSIUM ON ACOUSTICS p 61–65

N67-18561 Federal Fire Council, Washington, D. C.
HIGH EXPANSION FOAM FOR FIRE SUPPRESSION
15 Dec. 1965 29 p Minutes of the Meeting held in Washington, D. C., Dec. 15, 1965
(AD-641970) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. HIGH EXPANSION FOAM AND SOME OF ITS APPLICATIONS FOR FIRE SUPPRESSION F. L. Brannigan (AEC, Washington, D.C.) p 2–14 (See N67-18562 08-34)
2. PROCUREMENT J. H. Holmead, Jr. p 15–18 (See N67-18563 08-34)
3. SPECIFICATIONS AND STANDARDS W. C. Petric (Gen. Serv. Admin.) p 18–20 (See N67-18564 08-34)

4. QUALITY CONTROL C. R. Wolfe (Gen. Serv. Admin.) p 20–28 (See N67-18565 08-34)

5. AIRCRAFT CRASH FIREFIGHTING FILM, "BLANKET FOR SURVIVAL" E. R. Thorsell (FAA) p 28–29 (See N67-18566 08-34)

N67-18562 Federal Fire Council, Washington, D. C.
HIGH EXPANSION FOAM AND SOME OF ITS APPLICATIONS FOR FIRE SUPPRESSION
Francis L. Brannigan (AEC, Washington, D. C.) *In its* High Expansion Foam for Fire Suppression 15 Dec. 1965 p 2–14 (See N67-18562 08-34) CFSTI: HC$3.00/MF$0.65

An overview discusses possible uses for high expansion foam in suppressing fires as well as the resulting smoke. Examples are given of the use of foam in a burying pit into which old files stacked 25 feet deep, were set on fire and in other large-scale burning operations. The use of foam is suggested for the protection of records, particularly in old buildings that do not have sprinkler systems. Other potential uses are in the containment of radioactive gas releases, on submarines, and in community riot situations where a Molotov cocktail may have been planted. It is noted that the foam must displace air equal to the volume of the expanded foam, and some safety measures are mentioned. High expansion foam is considered three-dimensional whereas water is only two-dimensional; and, therefore, foam can do a better job on fires that are three-dimensional. M.W.R.

N67-18563 Federal Fire Council, Washington, D. C.
FEDERAL SUPPLY SERVICE AND WHAT IT MEANS TO FEDERAL FIRE SAFETY PERSONNEL: PROCUREMENT
John H. Holmead, Jr. (Gen. Serv. Admin.) *In its* High Expansion Foam for Fire Suppression 15 Dec. 1965 p 15–18 (See N67-18562 08-34) CFSTI: HC$3.00/MF$0.65

Procurement of portable fire fighting equipment by agencies of the federal government through the Federal Supply Service is discussed; and some of the available fire extinguishers, repair parts, extinguishing agents, and fire hose are listed. Sales of the portable equipment, which come to about one and a half million dollars each year, are to small users within the government. Users of large quantities go directly to the manufacturers. It is noted that sodium bicarbonate and carbon tetrachloride extinguishers are not longer available through the supply system. M.W.R.

N67-18564 Federal Fire Council, Washington, D. C.
FEDERAL SUPPLY SERVICE AND WHAT IT MEANS TO FEDERAL FIRE SAFETY PERSONNEL: SPECIFICATIONS AND STANDARDS
William C. Petrie (Gen. Serv. Admin.) *In its* High Expansion Foam for Fire Suppression 15 Dec. 1965 p 18–20 (See N67-18562 08-34) CFSTI: HC$3.00/MF$0.65

In addition to providing specifications and technical assistance to procurement, the standardization group within the Federal Supply Service develops standards for various products and participates in the Federal Catalog Program. Various sources of fire fighting equipment standards are mentioned, as are cooperative efforts to maintain quality according to government specifications. M.W.R.

N67-18565 Federal Fire Council, Washington, D. C.
FEDERAL SUPPLY SERVICE AND WHAT IT MEANS TO FEDERAL FIRE SAFETY PERSONNEL: QUALITY CONTROL
Charles R. Wolfe (Gen. Serv. Admin.) *In its* High Expansion Foam for Fire Suppression 15 Dec. 1965 p 20–28 (See N67-18562 08-34) CFSTI: HC$3.00/MF$0.65

Maintenance of quality control in fire fighting equipment distributed through the Federal Supply Service is discussed, and provisions in contracts for the inspection and testing of manufactured items is mentioned. Procedures are outlined for determining if required specifications are made by the manufacturer, and investigations of complaints by equipment users are discussed. M.W.R.

N67-18566 Federal Fire Council, Washington, D. C.
AIRCRAFT CRASH FIREFIGHTING FILM, "BLANKET FOR SURVIVAL"
Eric R. Thorsell (FAA) *In its* High Expansion Foam for Fire Suppression 15 Dec. 1965 p 28–29 (See N67-18562 08-34) CFSTI: HC$3.00/MF$0.65

Mention is made of fire tests to determine survival conditions within aircraft fuselages. Five C-97 aircraft, insulated to make them thermally comparable to passenger jet aircraft, were used; and 78 instruments were installed in and around the aircraft to record air and skin temperatures, and to take samples of the atmosphere to check for toxic gases. All aspects of the fire tests were documented in color by seven movie cameras located on the aircraft and at various outside points. The resulting film is entitled "Blanket for Survival." M.W.R.

N67-18621*# National Academy of Sciences—National Research Council, Washington, D. C.
POPULATION GROWTH IN MAN AND ITS CONSEQUENCES CONSEQUENCES
Gerald Piel, ed. 1964 39 p refs Proc. of the XVI Intern. Congr. of Zoology, Vol. 9, Held at Washington, 20–27 Aug. 1963 (Grant NsG-364)
(NASA-CR-82102) CFSTI: HC$3.00/MF$0.65 CSCL 05K

CONTENTS:

1. POPULATION K. Davis (Calif. Univ.) p 3–14 (See N67-18622 08-34)

2. PRODUCTION R. Calder (Edinburg Univ.) p 15–23 (See N67-18623 08-34)

3. THE LIVING GENERATION G. Piel p 24–32 (See N67-18624 08-34)

N67-18622*# California Univ., Berkeley.
POPULATION
Kingsley Davis *In* NAS—NRC Population Growth in Man and Its Consequences 1964 p 3–14 (See N67-18621 08-34) CFSTI: HC$3.00/MF$0.65 CSCL 05K

The sociological implications of the explosive increase in the human population are discussed. Population dynamics is reviewed in historical perspective to present problems. Factors appearing to affect the population growth of countries such as: 1) natural increase, 2) the effects of improved public health and medical prpcedures on declining birth mortality rates and increased longevity, 3) the use of birth control devices by the population, 4) emigration, 5) state of technology, and 6) economic conditions, are discussed. The effects of industrialization on changing the motives of people from agrarian societies to limit their families because of new open opportunities to get material goods, education, and influence, are also discussed. L.S.

N67-18623*# Edinburgh Univ. (Scotland).
PRODUCTION
Ritchie Calder *In* NAS—NRC Population Growth in Man and Its Consequences 1964 p 15–23 (See N67-18621 08-34) CFSTI: HC$3.00/MF$0.65 CSCL 05K

Man and his relationship to the forces of nature and the resources of the earth are examined in terms of food production. Examples of man's mismanagement of arable lands, and his interference with the lithosphere, atmosphere, hydrosphere, and biosphere are discussed. Implications of the population explosion, birth control, and future prospects for increasing world food production are covered. The proper application of technology, training, inland fish farming, methods of protein supplement, irrigation of deserts, domestication of sea-creatures, and cultivation of the oceans are mentioned as possible means for increasing food production. R.N.A.

N67-18624*# National Academy of Sciences—National Research Council, Washington, D. C.
THE LIVING GENERATION
Gerald Piel *In its* Population Growth in Man and Its Consequences 1964 p 24–32 (See N67-18621 08-34) CFSTI: HC $3.00/MF $0.65 CSCL 05K

An article concerning the foundings of industrial societies, and the effects of industrialization on the society of the country being industrialized is presented. The present state of industrialization in developed and underdeveloped countries is discussed; and an argument is made that instead of using the surplus of advanced industrial nations for armaments, foreign aid on a large scale would be a much better investment. L.S.

N67-18661 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
SCIENTIFIC SESSIONS OF THE O.N.E.R.A. [JOURNEES SCIENTIFIQUES DE l'O.N.E.R.A.]
[1966] 41 p refs In FRENCH Conf. held at Paris and Meudon, France, 23–25 Jun. 1966
CFSTI: $3.00

Summaries of conference papers in French on synthesis studies, physics, propulsion, materials, structures, and aerodynamics are presented. For individual titles see N67-18662–N67-18687.

N67-18662# France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
CONTRIBUTION OF FLIGHT EXPERIMENTATION TO AEROSPACE RESEARCH [CONTRIBUTION DE L'EXPERIMENTATION EN VOL A LA RECHERCHE AEROSPATIALE]
J. Bouttes and P. Lycrisse *In its* Sci. Sessions of the O.N.E.R.A. [1966] p 5 (See N67-18661 08-34) CFSTI: $3.00

A brief conference summary of technological experiments conducted by the National Office of Aerospace Studies and Research is presented. Some of these experiments are on: supersonic ramjet functioning, hybrid propulsion, kinetic heating of space vehicles reentering the atmosphere, an analysis of infrared contrast between the earth and space, propulsion systems, and turbulent-laminar transitions. Ancillary experimental results of significance pertain to flight measurements of aerodynamic coefficients, wind tunnel test results, and evaluation of trajectory tracking by statistical comparison of data obtained. Transl. by R.Li.

N67-18962*# Department of Housing and Urban Development, Washington, D. C.
SCIENCE AND THE CITY
Volta Torrey (NASA, Washington, D. C.) Jan. 1967 45 p
(HUD-MP-39) GPO: HC $0.45; CFSTI: MF $0.65 CSCL 05J

The problems besetting cities and the need for urban renewal and development in the inner core are discussed from the viewpoint of how science and technology can be directed to find the necessary new approaches and provide the needed physical facilities and social environment. It is pointed out that the space agency integrated the efforts of government, universities, and industry to put our country into the race for the moon. In brief, a systems approach was taken to bring together the diverse talents of people engaged in a wide range of scientific and technological disciplines. The need for improved information processing and dissemination is stressed. Model city programs are discussed, and an analogy drawn between such local projects and the astronauts' pre-Apollo flights. It was generally concluded that the kind of forced-draft technological effort that has characterized the development of space and weapons systems needs now to be applied to the urban task. M.G.J.

N67-18970# Illinois Univ., Urbana. Coordinated Science Lab.
NO TITLE Progress Report, Mar.–Aug. 1966
31 Oct. 1966 210 p refs
(Grants NsG-443; NsG-504; NsG-378; NGR-14-005-038; Contract DA-28-043-AMC-00073(E))
(NASA-CR-82394; AD-641851) CFSTI: HC $3.00/MF $0.65

Research progress in the following areas is reported: Surface Physics, Applied Physics, Plasma Physics, Rarefied Gas Dynamics, High Voltage Breakdown, Space Sciences, PLATO, Computer Systems and Applications, Plasma Display, Infrared Converter, Information Science, Networks, Control Systems, Structural-System Design, Switching Systems. Author (TAB)

N67-18975*# Massachusetts Inst. of Tech., Cambridge. Alfred P. Sloan School of Management.
THE DIFFERENTIAL PERFORMANCE OF INFORMATION CHANNELS IN THE TRANSFER OF TECHNOLOGY
Thomas J. Allen Jun. 1966 30 p refs Presented at the MIT Conf. on Human Factors in the Transfer of Technol., 19 May 1966 *Its* Working Paper 196-66
(Grants NsG-235-62; NSF GN-233; NSF GN-353)
(NASA-CR-82400) CFSTI: HC $3.00/MF $0.65 CSCL 05A

The manner of information dissemination among engineers and scientists, and the impact which various information gathering practices have upon the quality of the research were investigated. A parallel research project was studied and the results are presented. Pre- and post-project interviews with individual scientists and engineers were conducted, and a record over a period of time of the progress of an individual or group was obtained. The information channels were divided into groups of intra- and inter-laboratory organizations. The principal conclusions are: (1) There is a serious misalignment between the quality of the ideas generated through the channels, and the frequency with which these channels are used by engineers. (2) Literature is not greatly used, and is mediocre in performance. (3) Better performing groups rely more upon sources within the laboratory. (4) A mismatch in information coding schemes appears to be responsible for in the ineffectiveness of communication across the organizational boundary. N.E.N.

N67-18987*# Bureau of Mines, Minneapolis, Minn. Twin Cities Mining Research Center.
MULTIDISCIPLINARY RESEARCH LEADING TO UTILIZATION OF EXTRATERRESTRIAL RESOURCES
Quarterly Status Report, Oct. 1, 1966–Jan. 1, 1967
1 Jan. 1967 41 p refs
(NASA Order R-09-040-001)
(NASA-CR-82469) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The Bureau of Mines and NASA are conducting a cooperative program to study the properties and applications of simulated lunar materials. Research is directed toward providing knowledge needed for development of an extraterrestrial mineral resource extraction, processing, and utilization technology for supporting and enhancing the economy of manned lunar and planetary missions. Summaries are presented for over twenty related studies. A.G.O.

N67-19074# National Aeronautics and Space Council, Washington, D. C. Executive Office of the President.
REPORT TO THE CONGRESS FROM THE PRESIDENT OF THE UNITED STATES: UNITED STATES AERONAUTICS AND SPACE ACTIVITIES, 1966
1966 175 p

A summary of aeronautics and space activities in the United States during 1966 is presented; and the roles of the National Aeronautics and Space Council, NASA, and other government and quasi-official agencies are described. Reviews of many projects

are included, space launchings made during the year are tabulated, and payload and other details are given for the successful launches. Major space "firsts" by both the United States and the U.S.S.R. are listed, as are fiscal 1967 budget recommendations. A historical summary of Gemini Project is given, and mention is made of SNAP radioisotopic electric power units for space. M.W.R.

N67-19278*# National Aeronautics and Space Administration, Washington, D. C.

AN INTRODUCTION TO THE EVALUATION OF RELIABILITY PROGRAMS

D. S. Liberman and A. J. Slechter (ARINC Res. Corp., Washington, D. C.) 1967 67 p refs Prepared jointly with ARINC Res. Corp.

(Contract NASw-1012)

(NASA-SP-6501) CFSTI: HC $3.00/MF $0.65 CSCL 14D

A basic orientation to the task of evaluating the effectiveness of a reliability program is presented. Primary emphasis is devoted to discussing the assurance task as it relates to project requirements and resources and to describing the factors which determine effectiveness in program implementation. The general fundamentals which apply to the treatment of reliability program objectives, the criteria for judging task effectivness, and the approach to evaluating the various tasks for meaningful accomplishment are discussed. A failure reporting procedure selected as typifying most of the key features of the better systems presently in use in the aerospace industry is also described. A.G.O.

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NASA is depositing its technical documents and bibliographic tools in eleven Federal Regional Technical Report Centers. Each center, located in one of the organizations listed below is prepared to furnish the general public such services as personal reference, interlibrary loans, photocopy service, and assistance in obtaining retention copies of NASA documents.

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"The aeronautical and space activities of the United States shall be conducted so as to contribute . . . to the expansion of human knowledge of phenomena in the atmosphere and space. The Administration shall provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof."

—NATIONAL AERONAUTICS AND SPACE ACT OF 1958

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